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[Gilyarov] Ghilarov (M. S.). **On the Causes of divergent Evolution in Soil inhabiting Click-beetle (Elateridae Col.) Larvae.**—*C. R. Acad. Sci. URSS* (N.S.) **36** no. 8 pp. 251–253, 4 refs. Moscow, 1942; also in Russian in *Dokl. Akad. Nauk SSSR* **36** no. 8 pp. 268–270, 4 refs. Moscow, 1942. [Recd. 1944.]

Elaterid larvae are of three morphological types. Some, such as those of the genera *Cardiophorus* and *Horistonotus*, are vermiform and poorly chitinised. Others, including those of the genera *Corymbites* (*Selatosomus*), *Ludius*, *Lacon* and *Pleonomus*, have a short broad body, are strongly chitinised and bear strong forked projections (urogomphi) on the caudal abdominal segment. Larvae of the type of *Agriotes* and *Melanotus* occupy an intermediate position and have a fairly elongated body with a compact wall, but no urogomphi.

The author considers that these differences in larvae belonging to the same family, subfamily, or even tribe, have been evolved as adaptations to different methods of migration in the soil. Larvae of the type of *Cardiophorus* are adapted to moving along already existing tunnels and spaces between soil particles, and the great pliability of their bodies is increased by the reduction of the chitinous skeleton and the development of supplementary segmentation. This method of migration favours the progressive development of such sense organs as antennae and ocelli. Larvae of this type chiefly abound in light or undisturbed soils. Larvae of the second group are adapted to digging actively in the soil, and have a head structure modified for this purpose. While digging, they are supported and kept in equilibrium by the urogomphi, and their stability is increased by the broad and shortened form of their bodies. Adaptation of this type is characteristic of larvae occurring in compact untreated soils, such as *Corymbites* (*Selatosomus*) *latus*, F., in European Russia, *Pleonomus tereticollis*, Ménétr., in Central Asia, and *Ludius* spp. in North America. The fact that larvae of the types of *Corymbites* and *Cardiophorus* frequently occur in similar soils indicates that the characters peculiar to each have developed in similar surroundings. Larvae of the intermediate group usually occur in looser soils.

Fraenkel (G.) & Blewett (M.). **The natural Foods and the Food Requirements of several Species of Stored Products Insects.**—*Trans. R. ent. Soc. Lond.* **93** pt. 2 pp. 457–490, 18 figs., 47 refs. London, 1943.

The following is based on the authors' summary. The dietary requirements of several common insect pests of stored products are analysed with a view to correlating them with the natural foods of these insects. Four main factors are recognised as of importance in the nutrition of insects, namely, requirements of carbohydrates, quantitative and qualitative requirements of sterols, moisture content of the food, and qualitative and quantitative requirements of vitamins of the B-group. Flour becomes an inferior food with increasing extraction. On low-extraction flour, *Tribolium confusum*, Duv., *Lasioderma serricorne*, F., and *Ephestia kuehniella*, Zell., grow relatively better than *Sitodrepa panicea*, L., *Ptinus tectus*, Boield., and *E. elutella*, Hb. When bred in flour in equilibrium with different relative humidities and therefore with different moisture contents, the insects grow better at a high than at a low humidity, but show quantitative differences in their reactions. *Tribolium*, *Oryzaephilus surinamensis*, L., and *E. kuehniella* still grow fairly well at about 6 per cent. water content, and *E. kuehniella* even at 1 per cent., whereas *Lasioderma*, *Sitodrepa* and *Ptinus* require at least 10 per cent. Grain, as it occurs in storage, usually has small lesions in the bran, and all the insects grow well on such grain. Newly-hatched larvae of *Tribolium*, *E. kuehniella*, *Oryzaephilus*, *Lasioderma* and *Sitodrepa* find it difficult to attack grain that is entirely undamaged, but older larvae, with the exception of those of *Oryzaephilus*, are able to do so. They feed chiefly in the germ region, but show characteristic differences, which are described, in their

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methods of attacking grains and causing damage. The results are given of attempts to breed the insects on a number of characteristic types of dried foods, including yeast, fish-meal, meat-meal, pea flour, dried fruits, dried milk and cocoa.

As a result of investigations into the basic food requirements of these insects [*cf. R.A.E.*, A **32** 81] and their reaction to flours of different extraction and moisture content, to whole grain and a number of widely different other dried foods, a detailed account of the food requirements and food habits of each insect is given.

In a postscript it is pointed out that *T. confusum*, *Dermestes maculatus*, Deg. (*vulpinus*, F.) and *E. kuehniella* acquire a substantial part of the water ultimately found in the body by oxidation of food, and at extremely low humidities the greater part of it is obtained in this way. The vitamin requirements of *L. serricorne* and *S. panicea*, when grown free of symbionts, resemble in every respect those of insects that have no intracellular symbionts, such as *T. confusum*, *P. tectus* and *E. elutella*. Unlike the normal larvae, those that are sterilised fail to grow in the absence of B_1, riboflavin, nicotinic acid, B_6, pantothenic acid and choline chloride. All the important vitamins of the B-group are therefore normally supplied by the symbionts. The requirements of B-vitamins of *E. elutella* closely resemble those of *Ptinus* and *Tribolium*, but it also requires a fat-soluble factor, contained in wheat germ oil, which is an unsaturated fatty linoleic acid, for growth. Unlike *E. kuehniella*, it grows well on artificial diets containing glucose as the carbohydrate, though not on those containing starch as the carbohydrate, and some growth occurs even in the absence of carbohydrates.

Glen (R.), King (K. M.) & Arnason (A. P.). **The Identification of Wireworms of economic Importance in Canada.**—*Canad. J. Res.* (D) **21** no. 11 pp. 358–387, 64 figs., 59 refs. Ottawa, 1943.

Work on the control of wireworms in Canada has in many instances been hindered because workers in the field have had no ready means of identifying the species with which they come into contact. The authors therefore discuss the characters of the larvae that are important for identification ; give a key based on them and also on distribution and habitat to the species that are injurious in Canada and species or groups of species that are common but not of economic importance, together with a list of the injurious species, showing their distribution and figures of most of them ; and briefly review the main distinguishing characters, habits and distribution of the chief taxonomic groups. It is hoped that simple field keys may be built up from this material to the species occurring in any particular locality.

Massee (A. M.). **The Egg of *Euacanthus interruptus* L. (Hem., Jassidae).**—*Ent. mon. Mag.* **79** no. 955 p. 270. London, 1943.

Euacanthus interruptus, L., is common in summer in many parts of Kent, where it is frequently a serious pest of hops and also infests many varieties of wild plants, though it usually occurs on grassy roadside banks and hedgerows [*cf. R.A.E.*, A **30** 325–326]. In a paper already noticed [**13** 105], Theobald stated that the eggs of this Jassid are laid in the poles and bines and that the adults sometimes overwinter in cracks in the poles. Since closely related species deposit their eggs in grass stems, however, a search for eggs of *E. interruptus* was made. In August and September 1943, large numbers of adults were observed ovipositing at random in the undamaged surface tissue of chestnut-wood poles in an infested hop garden. They showed no preference for cracks and crevices in older, weathered poles, and were not seen to oviposit in hop-stems. Observations on a grassy bank adjoining a rough field where the Jassid was

known to breed freely showed that eggs were being laid in the posts of a chestnut fence adjoining the bank and in the dead snags and dead shoots of a neighbouring pollarded poplar wind-break, and similar observations were made in other localities. The author concludes that winter is passed only in the egg stage. A brief description of the egg, based on examples taken from chestnut-wood hop poles, is appended.

HINTON (H. E.). **A Key to the Species of** *Carpophilus* **(Col. Dermestidae) that have been found in Britain, with Notes on some Species recently introduced with stored Food.**—*Ent. mon. Mag.* **79** no. 955 pp. 275–277. London, 1943.

Of the nine species of Nitidulids of the genus *Carpophilus* that have been found in Britain, all have apparently been introduced with stored food products. The only ones recorded there before 1900 were *C. hemipterus*, L., *C. dimidiatus*, F., and *C. sexpustulatus*, F., and these and also *C. ligneus*, Murr., *C. marginellus*, Motsch., and probably *C. obsoletus*, Erichson, are considered to be established. *C. marginellus* is widely distributed in the Indo-Australian region and apparently North America, where it has been recorded as injuring stored rice, and occurs in Madagascar. The author has taken it in California and seen specimens from New Jersey. A single individual was taken at sap in Britain in 1938, and the author obtained over 300 examples in October 1943 from damp, warm, germinating wheat in pits and crevices in a London flour mill. No larvae were found, but adults taken to the laboratory bred satisfactorily on fresh or slightly fermented apple. *C. obsoletus* is known to infest stored rice, wheat, maize, ground-nuts and seeds of *Sesamum* in Japan, cereals in Formosa [*cf. R.A.E.*, A **17** 110; **25** 305], copra in Malaya and maize cobs in Palestine. In 1938, it was recorded in London and Manchester in jars of ginger preserved in syrup, and the author has recently received living examples found in Glasgow on copra from Ceylon, and has seen living adults collected in a London warehouse. *C. flavipes*, Murr., has only once been found in Britain and must be regarded as an accidental introduction.

Two further species, *C. humeralis*, F., and *C. maculatus*, Murr., are here recorded from Britain for the first time. The record of *C. humeralis*, which is now established in nearly all tropical countries, is based on dead specimens found on two occasions in canned pineapples. It is a serious pest in pineapple fields in Hawaii [*cf.* **18** 253; **21** 229; **24** 186], where it has greatly increased in abundance during the past ten years and is a nuisance in the canneries. *C. maculatus* is widely distributed in the Indo-Australian region and is also a pest in pineapple fields in Hawaii [**24** 186]. It has been recorded as infesting growing maize in Java. A few adults have recently been found in Glasgow in copra imported from Ceylon, and it is thought possible that this species may become established in Britain.

A key is given to the adults of the nine species dealt with, together with notes on the synonymy of *C. marginellus* and *C. maculatus*.

CORBET (A. S.). **Observations on Species of Lepidoptera infesting stored Products. XII.** *Tinaea secalella* **Zacher (the Rye Moth), a Synonym of** *Tinaea infimella* **Herrich-Schäffer (Tinaeidae).**—*Entomologist* **76** no. 967 pp. 252–253. London, 1943.

Examination of the original preparations has shown that the figure given by Pierce & Metcalfe in 1935 of the male genitalia of the species of *Tinea* (*Tinaea*) described by them in 1934 as *T. personella* is incorrect, since the gnathos is in reality serrate on one side only. *T. secalella*, Zacher [*cf. R.A.E.*, A **27** 220; **30** 249] is therefore a synonym of *T. personella*, and the latter has already been shown to be a synonym of *T. infimella*, H.-S. [**31** 518]. The observations of

Mathlein on this Tineid as a pest of stored grain in Sweden [**31** 281] are briefly summarised. Larvae of *T. infimella* have been recorded in Britain only from fungi, but in view of continental observations the species must be regarded as a potential pest of stored rye.

APPEL (O.). Ed. **Pflanzenschutz. Verhütung und Bekämpfung der Pflanzenkrankheiten.** [Plant Protection. The Prevention and Control of Plant Pests and Diseases.]—In SORAUER (P.). *Handb. Pflanzenkr.* **6** II. Halbband, viii+732 pp., 184 figs., many refs. Berlin, Paul Parey, 1941. [Recd. 1944.]

This second half-volume of the sixth (final) volume of Sorauer's text-book (of which pp. 1–208 were issued separately and have already been noticed [*R.A.E.*, A **27** 290]) contains the sub-section on biological control (pp. 1–120) and six further main sections. In the first five of these, various authors discuss the apparatus used in plant protection work (pp. 121–303), the methods and criteria employed in determining the healthiness or otherwise of seeds or other planting material and the purity of resistant plant strains (pp. 304–361), the cultivation and breeding of varieties that are resistant to pests and diseases (pp. 362–406), legislation dealing with the control of pests and diseases of cultivated plants in Germany and, more briefly, in other countries (pp. 407–583), and the history and functions of the official bodies responsible for plant protection work in Germany and, in less detail, elsewhere (pp. 584–632). The final section (pp. 633–664) contains lists of the principal monographs, journals and serial and occasional publications in many languages dealing with the various aspects of plant protection. An index to the whole of the sixth volume is appended.

MUNGOMERY (R. W.). **Report of the Division of Entomology and Pathology.**—*43rd Rep. Bur. Sug. Exp. Stas Qd* pp. 18–19. Brisbane, 1943.

Damage to sugar-cane by larvae of the Melolonthid, *Dermolepida albohirtum*, Waterh., in Queensland in the year ending 30th June 1943 was the heaviest recorded in recent years [*cf. R.A.E.*, A **30** 509]. There was increased widespread infestation in certain northern areas, and the situation was aggravated by difficulties in the transport of fumigants and shortage of labour. In many cases infestation averaging one or two larvae per stool caused appreciable losses where three or more are normally required to produce any noticeable effect; this is attributed in part to increased susceptibility of the plants as a result of a shortage of fertilisers and to a greater extent to exceptionally dry weather after March that caused a further deterioration in the damaged plants. In addition to the cane injury, serious damage also occurred to the stools, as a result of which ratooning is likely to be adversely affected. In the Mackay district, damage followed early December rains and unfavourable autumn weather, and though sporadic, was the heaviest recorded for five years, but in the central area its effect was diminished by the June rains. The hand collection of beetles was reintroduced there and in the Burdekin district, but damage was heavy despite the large numbers destroyed. An attempt to inoculate larvae of *D. albohirtum* with the spores of *Bacillus popilliae* and *B. lentimorbus*, the causal organisms of the milky disease of *Popillia japonica*, Newm., in the United States, was unsuccessful.

Infestation by *Lepidiota frenchi*, Blkb., was fairly intensive in some areas, but good growing conditions in summer largely counteracted its effects. The ploughing and replanting of large areas under sugar-cane necessitated by the attacks of *D. albohirtum* may favour increased populations of *L. frenchi*.

Rhabdoscelus (*Rhabdocnemis*) *obscurus*, Boisd., was of less importance than in recent years, and this is attributed to the lighter, less succulent crops with

fewer lodged stalks produced as a result of reduced applications of fertilisers, the light incidence of top-root disease, and, in wet areas, to control by the toad, *Bufo marinus* ; numbers are expected to be still further reduced by the burning of an increased proportion of cane in the 1943 harvesting season [*cf.* **25** 740]. There were few serious outbreaks of *Lacon variabilis*, Cand., in the spring of 1942. In the Mackay district, where a considerable amount of early planting, extending in some cases into May and June, was carried out, only a few attacks by this wireworm were reported ; it is likely to be injurious in low-lying districts that are planted during the spring.

There was an increase in the incidence of Fiji disease [*Galla fijiensis* of Holmes] in the Bundaberg district, brought about by the large populations of the vector [*Perkinsiella saccharicida*, Kirk.] that survived the mild winter of 1942, and by a small and intensive, though isolated, outbreak that occurred in one area, but the total number of stools destroyed was equivalent to little more than one acre, and the increase is not considered to be of importance. Resistance trials showed that certain cane varieties are highly resistant to the disease, though Hawaiian canes were susceptible.

WOLCOTT (G. N.). **Criteria for *Trichogramma*.**—*Trop. Agriculture* **20** no. 11 pp. 221–222, 3 refs. Trinidad, 1943.

The main conclusions reached in this discussion of the usefulness of liberating *Trichogramma minutum*, Ril., in sugar-cane fields in Porto Rico for the control of *Diatraea saccharalis*, F., based on work on experimental releases of a laboratory-reared stock and on natural parasitism by *Trichogramma* in the island, have already been noticed [*cf. R.A.E.*, A **32** 53]. Weather conditions favour oviposition by *D. saccharalis* throughout the year, but the mean summer temperatures (80°F. or more) are slightly more favourable for oviposition by *Trichogramma* than the mean winter temperatures (a few degrees below 80°F.). Releases are commercially justified only in the latter season and only in individual fields [*loc. cit.*], since the parasite normally increases so rapidly when host eggs become numerous that there is no opportunity for accelerating its natural effect. As *Trichogramma* and newly-hatched larvae of *Diatraea* are both dispersed by wind and the moths fly in all directions, the effects of liberating the parasite cannot be evaluated by comparing the amount of stalk injury in adjoining fields in which liberations have and have not been made ; furthermore, it is unlikely that the effect due to parasites released against first-generation eggs will persist through the seven generations of *Diatraea* that occur during the time required for sugar-cane to reach maturity (10–16 months). The only criterion for the value of a release is a marked increase in parasitism within a few days or weeks of it.

SCHECHTER (M. S.) & HALLER (H. L.). **The insecticidal Principle in the Fruit of the Amur Corktree.**—*J. organic Chem.* **8** no. 2 pp. 194–197, 9 refs. Baltimore, Md., 1943.

An account is given of studies on the insecticidal properties of the fruit of *Phellodendron amurense* [*cf. R.A.E.*, A **29** 414]. Attempts to isolate the toxic principle were unsuccessful, but an unsaponifiable fraction in acetone solution was considerably more toxic to house-flies [*Musca domestica*, L.] than the petroleum-ether extractive from which it was obtained, and methods by which two highly toxic fractions were obtained from it are described. The toxicity tests were carried out with acetone solutions, because even the most potent fractions exhibited little or no toxicity in high-boiling kerosene. The toxic constituent did not react with phthalic anhydride, and no crystalline derivatives of it could be obtained ; since it was not inactivated by treatment with

alkali, it differs from other naturally occurring insecticides, such as the pyrethrins and rotenone, the absence of which was confirmed by qualitative tests.

The fruit of *Phellodendron lavallei* was also found to contain a toxic principle.

CHISHOLM (R. D.) & KOBLITSKY (L.). **Determination of Paradichlorobenzene in Soil.**—*J. Ass. off. agric. Chem.* **26** no. 2 pp. 273–277, 1 fig. Washington, D.C., 1943.

One of the methods authorised in the United States for treating nursery stock to kill the Japanese beetle [*Popillia japonica*, Newm.] involves plunging the plant balls into a mixture of paradichlorbenzene and soil [*cf. R.A.E.*, A **24** 258; **26** 384; **28** 89]. This mixture has hitherto been discarded after use, but a method for determining the residual paradichlorbenzene would make it possible to add sufficient paradichlorbenzene to the used mixture to restore the original concentration and thus reduce the cost of the treatment by avoiding waste of the chemical and the necessity for procuring and preparing large amounts of soil. By the method here described, the paradichlorbenzene is removed from samples of the used soil mixture by steam distillation and recovered in highly refined kerosene; the difference between the refractive index of the solution and that of the kerosene is determined, and the concentration of paradichlorbenzene in the soil is calculated from this by means of a linear equation.

In tests to determine the accuracy to be expected in view of the variation in the amount of paradichlorbenzene taken for a determination and the errors of sampling naturally inherent in the soil mixtures, analysis of six mixtures of paradichlorbenzene and sassafras sandy loam, which had contained 6–10 lb. paradichlorbenzene per cu. yard before being used for the treatment of nursery plants, showed concentrations of 2·2–6·34 lb. per cu. yard, with a mean difference in duplicate analyses of about ¼ lb. per cu. yard.

It is suggested that this method may be used for the determination of other volatile compounds, such as naphthalene.

BUSBEY (R. L.) & FULTON (R. A.). **Spray Residues of Tartar Emetic on *Citrus* Leaves. Determination by iodometric Titration.**—*Industr. Engng Chem.* Anal. Ed. **15** pp. 37–38, 2 refs. Easton, Pa., 1943.

The author describes a method of determining the residue of tartar emetic left on orange or lemon leaves or lemon fruits after the application of sprays of tartar emetic and sugar for the control of thrips, particularly *Scirtothrips citri*, Moult., in California. The antimony residues are removed from the leaves by washing with a 1 per cent. solution of tartaric acid and determined by titrating with standard iodine solution in the presence of sodium bicarbonate. Preliminary experiments showed that this titration was not significantly altered by the presence of sucrose or tartaric acid, but the method cannot be used in the presence of arsenites, which, however, are seldom if ever applied to *Citrus*.

The residues on orange foliage from a spray containing 1½ lb. tartar emetic and 2 lb. sugar per 100 U.S. gals. were found to contain antimony equivalent to 6·6–10·7 mmg. tartar emetic per sq. cm. immediately after spraying, but these residues were greatly reduced by rain.

[BISSELL (T. L.).] **Entomology.**—*54th Rep. Ga Exp. Sta. 1941–42* pp. 77–83, 3 figs. Experiment, Ga. [1942.]

Work on insect pests in Georgia during 1941 again included observations on the dates of emergence from hibernation of adults of the cowpea curculio [*Chalcodermus aeneus*, Boh.] estimated by collecting them on cowpea plants set as traps in the field [*cf. R.A.E.*, A **29** 598]. The first was taken exceptionally

early, on 16th April. Large numbers emerged during the week ending 16th May ; collections were small after 15th June but rose towards the end of July, when a new generation emerged. Of overwintered weevils caged on plants without pods to ascertain the length of survival [*cf. loc. cit.*], 20, 41 and 73 per cent. were dead by 1st July, 1st August and 1st September, respectively ; 5 out of 63 went into hibernation, but none survived the winter. Co-operative observations in Georgia and South Carolina on the effect of date of planting on infestation showed that infestation was lower in the later plantings [*cf. loc. cit.* ; **32** 58], though rather more damage occurred on the latest planting (15th July) than on the preceding one (26th June). The injury was reduced by dusting with sodium fluosilicate, but not by thinning. At two localities further south in Georgia, weevil damage was comparatively light in the first plantings and heavier in those picked in August. Plants a month old were killed during very dry weather early in June by large numbers of weevils emerging from hibernation, which punctured the stems. The Tachinid, *Myiophasia globosa*, Tns., was observed parasitising the larvae on 11th July, in the earliest set peas, but parasitised larvae were not found after 1st September, though unparasitised ones were present up to mid-October. Five Hymenopterous parasites were also reared from the weevil, but none is so effective as *Myiophasia*.

Experiments on the effect of dates of ploughing under winter peas and sowing maize on damage to the latter by the southern corn rootworm [*Diabrotica duodecimpunctata*, F.] confirmed the results obtained in previous years [*cf.* **29** 599], and a definite relation was found between low infestation and high yield.

Work on cotton pests included observations on *Systena blanda*, Melsh., some of which have already been noticed [**30** 484]. There was a further outbreak of this flea-beetle in 1942, though rainfall had been almost normal during the preceding winter. Its distribution was somewhat greater than in 1941, but damage appeared to be lighter. The counties in which it was reported in 1941 and 1942 are shown on a map.

Wheat in four counties was injured in the spring of 1942 by *Sphenophorus* (*Calendra*) *venatus*, Say, the larva of which appears to mine at the base of one stem of a wheat plant and then to feed on the roots of the remaining stems, so that the whole plant is affected. The mined stems, the heads of which are prematurely whitened, break off at ground level. Adults emerge from the soil after harvest and are believed to breed in grasses at the sides of fields, from which infestation spreads to the wheat. Of 200 wheat stems examined for damage from each of three sides of one field, the percentages mined were 4·5, 0 and 6·8, respectively, but this did not show the amount of root feeding. A Cecidomyiid of the genus *Neolasioptera* emerged from a wheat stem on 1st June. It had pupated in a hole just above the top node, and the central stem was cut off inside.

Observations on infestation of ground-nuts and partridge pea (*Chamaecrista*) by *Stegasta bosquella*, Chamb., showed that little damage has occurred to the former in Georgia [*cf.* **30** 529]. *Chamaecrista*, which is of some value in soil conservation, is also attacked by an undescribed species of *Conotrachelus* in Georgia and Alabama, and the roots are infested by a mealybug, possibly *Pseudococcus maritimus*, Ehrh. Damage by *Elasmopalpus lignosellus*, Zell., to leguminous plants, including autumn-sown beans, is fairly common in Georgia. The larva bores into the stem at ground level and usually forms a silken tube outside. Infestation is most usual in late summer or autumn, but ground-nuts in southern Georgia are attacked in the spring. Seedlings of kudzu bean [*Pueraria hirsuta*] were attacked and killed in one locality in September 1941. Of 2,500 mature cowpea plants examined in October, 39 per cent. had been attacked though not greatly damaged. There was some mortality among cowpea seedlings examined at the same time.

Zonosemata electa, Say, which is a pest of pepper [*Capsicum*] in New Jersey [*cf.* **24** 257], has only been reported in Georgia as breeding in the fruits of horse-nettle (*Solanum carolinense*). Larvae were found in fruits of this weed in late November, though most had entered the soil to pupate. Adults of this Trypetid and of *Opius sanguineus*, Ashm., emerged in May and June from pupae collected in December, 40 per cent. of which were parasitised by the Braconid.

De Bach (P.). **The Importance of Host-feeding by adult Parasites in the Reduction of Host Populations.**—*J. econ. Ent.* **36** no. 5 pp. 647–658, 4 figs., 9 refs. Menasha, Wis., 1943.

The author reviews field observations in California in 1941 and 1942, which showed that the successful control of *Saissetia oleae*, Bern., on *Citrus* by *Metaphycus helvolus*, Comp. [*cf. R.A.E.*, A **31** 90, 245] is not solely due to parasitism, as the females of this Encyrtid kill many of the scales by mutilation with the ovipositor and by feeding at wounds made by the ovipositor. It appeared that approximately 70–97 per cent. of a population of the Coccid may be killed by *M. helvolus* in a few months, about 20–25 per cent. of the mortality being due to parasitism and the rest to host-feeding, and that the relative importance of host-feeding is greatest during the early phases of an infestation and that of parasitism later, as the scale increases in size. Laboratory tests, each involving one parasite generation, were therefore carried out in which 1, 5 or 10 adult females of *M. helvolus* were enclosed with potato shoots infested with scales of a suitable size, to study the effect of scale size (or age), host population density and parasite population density on the degree of parasitism, the amount of host-feeding and the relation between them.

The following is based on the author's summary of the results obtained. Within limits, the percentage parasitism was not markedly affected by the number of parasites, but the percentage killed by host-feeding increased as the parasite density increased; total mortality due to host-feeding was much greater than that due to parasitism. Percentage parasitism increased with the host density at the parasite densities tested, up to a point where the maximum rate of parasite reproduction was reached, whereas the percentage mortality due to host-feeding decreased. The latter was the greater in all cases and increased with respect to parasitism at the higher parasite densities. Parasite fertility was greatest with one female parasite per infested shoot, and, because of the limitation of the egg-laying capacity, reached a maximum of 70 progeny at a host density of about 400 scales. Fertility was much lower at parasite densities of 5 and 10 per shoot, probably because of competition between female parasites. Host-feeding per parasite increased slightly as host density increased, although not so rapidly as parasitism. Host-feeding mortality per parasite was greatest with one parasite per shoot and least with 10 per shoot. In every case host-feeding was greater than parasitism. In general, as scale size increased, total mortality due to parasites increased. The percentage parasitism increased rapidly as the hosts ranged from very small to medium-sized scales and then more slowly to large ones. The percentage host-feeding mortality decreased as the hosts ranged from small to medium-sized scales and then increased with large ones. The latter was much greater than the percentage parasitism when the scales were small and slightly greater when they were large, but was somewhat less at the intermediate size. The studies indicated that scales are parasitised when they are 0·4–2 mm. in length.

Decker (G. C.). **Toxic-dust Barriers for Chinch Bug Control.**—*J. econ. Ent.* **36** no. 5 pp. 658–661, 1 ref. Menasha, Wis., 1943.

In view of a shortage of creosote, barriers of dinitro compounds were tested against the chinch bug [*Blissus leucopterus*, Say] in Iowa in 1942. Barriers of

dusts containing 2, 4, 8 and 12 per cent. 3, 5, dinitro-o-cresol, dinitro-o-secondary-butylphenol or dinitro-o-cyclohexylphenol in pyrophyllite, with or without the addition of 5 per cent. mineral oil, were all effective in preventing migrating bugs from reaching maize and gave about equal protection. This was confirmed in tests in which fifth-instar nymphs and adults were placed inside circles of dust that were surrounded by circles of creosote ; two hours later the number of living bugs between the dust and the creosote barriers was greater for dinitro-cyclohexylphenol than for the other dusts, showing the slow action of this material, but after five hours all the bugs except a few that remained under clods in the central area were dead in all the plots. Barriers of 8 per cent. dinitro-cresol in pyrophyllite, applied at rates of $\frac{1}{4}$, $\frac{1}{2}$ and 1 lb. per rod [$5\frac{1}{2}$ yds.] to determine the required rate of application, all proved effective when carefully constructed. The lighter lines were more easily destroyed by wind, but remained effective for several days when the wind velocity did not exceed 15 miles per hour ; at higher velocities, all dust lines were affected. Dusts containing oil were slightly more resistant than those without. As all the lines were seriously damaged or destroyed by heavy rains, such as occurred on 17 days between 15th June and 31st July, it is considered that repeated applications at the lowest rate should be made.

Of 15 farmers who tested a dust of 8 per cent. dinitro-cresol, 5 per cent. oil and 87 per cent. pyrophyllite, the majority considered it more effective than creosote. Better lines could be laid, in less time, with the dust without oil, and barriers of this material were as effective as those with oil and even killed the bugs more quickly.

In laboratory studies to obtain data on the lower limits of practical dilution, bugs were released inside rings of dusts containing 1, 2, 4 and 8 per cent. of the three compounds and collected after they had walked through the dust. There was great variation in the amount that adhered to the insects in repeated tests, but all fifth-instar nymphs and adults that passed the highest concentration and 33–88 per cent. of those that passed the lowest were dead after 24 hours. At concentrations of 1 and 2 per cent., dinitro-secondary-butylphenol was significantly more toxic than the other materials. All adult and fifth-instar bugs that were shaken up in a vial with 1 per cent. dusts of the three compounds for 10 seconds and then jarred to remove surplus dust were dead within two hours, though dinitro-cyclohexylphenol was slower in action than the others ; statistical analysis showed that dinitro-secondary-butylphenol gave significantly higher mortality than dinitro-cresol after 10 and 15 minutes. In similar tests, 8 per cent. dusts of 2, 4, dinitro phenol, the ammonium and dicyclohexylamine salts of dinitro-cresol, dinitro-cyclohexylphenol and dinitro-secondary-butylphenol, and the sodium salts of the first two of these in pyrophyllite all gave complete kill within a few hours, but showed some differences in the speed of action, the ammonium salts of the cresol and butylphenol being comparable in toxicity with the original compounds [*cf. R.A.E.*, A **32** 171]. It is considered that any of the compounds tested might be successfully used in barriers, and that market price and speed of action should determine the selection.

All the dusts studied were highly effective when applied to kill bugs in post holes used as traps in front of creosote barriers, and a thin layer of dust on the ground in front of the barrier could be substituted for post holes, though piles of dust at intervals were not effective, since they interfered with the forward march of the bugs, so that some of them crossed the creosote line without coming into contact with the dust. They also gave very effective control of bugs that had accumulated at the base of maize plants ; all the dusts tested were equally effective and none of them caused serious scorching if only the base of the stalks was dusted. The results of tests to determine the tolerance of maize and oats to the various dusts are shown in a table.

Smith (R. F.) & MacLeod (G. F.). **Alfalfa Butterfly Control with Sulphur Dusts.**—*J. econ. Ent.* **36** no. 5 pp. 665–671, 5 figs., 16 refs. Menasha, Wis., 1943.

In spite of natural control by the parasite, *Apanteles flaviconchae*, Ril., and a wilt disease, larvae of *Colias eurytheme*, Boisd., frequently cause serious damage to lucerne in the southwest of the United States, particularly from July to September and in the San Joaquin Valley, California. No satisfactory insecticide has been found for use against this pest, owing to the relatively low value of each single cutting of lucerne, the risk of poisoning the hay, the danger to the parasite from contact insecticides and the wide fluctuations in populations due to the parasite, wilt disease and weather conditions, which have hampered experiments. In the course of *Lygus* counts on lucerne on Union Island in 1940, however, it was observed that the larvae were significantly less abundant on plots that had been dusted with sulphur than on untreated ones and that their frequency decreased as the rate of application increased from 50 to 100 lb. per acre, though it was not affected by a further increase to 200 lb. Applications of a dusting sulphur alone or with 0·75 per cent. arsenic trioxide at 30 lb. per acre or of a mixture of equal parts of sulphur and calcium arsenate at 13 lb. per acre on 29th July 1942 failed to give satisfactory control, though all the treatments caused significant reductions in the total numbers of larvae on the plants, with no significant differences between treatments, after five days. After seven days, all the treated plots had fewer large larvae than the control plots, in which the preponderance of large larvae over small or medium-sized ones was the greatest. The plot that had received sulphur alone contained significantly more medium-sized larvae than small ones, and more total larvae and significantly more medium-sized larvae than any other plot, probably because the amount of sulphur applied killed only 30 per cent. of the larvae, but caused many of the others to cease feeding, with the result that pupation was greatly reduced and many big larvae shrank in size (except for the head capsule) and were classed as medium ones. The dust containing arsenic trioxide scorched the plants slightly. Applications of sulphur dusts containing at least 98 per cent. sulphur or 95 per cent. with 5 per cent. wetting and dispersing agents, at the rate of 70 lb. per acre, gave significant reductions in the numbers of larvae, resulting in over 65 per cent. reduction in total larvae and as much as 80 per cent. of large ones, which do the greatest damage, but no significant reduction in the numbers of small and medium-sized larvae ; this would afford satisfactory control under almost all conditions.

The authors discuss the possible mode of action of sulphur as a stomach insecticide and its use against other insects from the literature and conclude that when natural control of *C. eurytheme* is not effective, treatment of the lucerne with dusting sulphur at 75 lb. per acre when it is 8 ins. high, early enough to allow the dust to dissipate before harvest, apparently gives good control. It is considered, however, that the rates of application, the effect on the parasite, the palatability of the hay and the timing of applications should be further investigated before definite recommendations are made.

Swain (R. B.). **Nematode Parasites of the White-fringed Beetles.**—*J. econ. Ent.* **36** no. 5 pp. 671–673. Menasha, Wis., 1943.

Since Nematodes of the genus *Neoaplectana* were found in white-fringed beetles (species of *Pantomorus* of the subgenus *Graphognathus*) collected in Mississippi in the autumn of 1940, and the latter became infested with *N. glaseri*, which attacks the Japanese beetle [*Popillia japonica*, Newm.] in laboratory experiments [*cf. R.A.E.*, A **31** 466], it was decided to search for possible Nematode and other parasites that might be used for their control. White-fringed beetles from all but one of the major areas infested by them were examined, and undetermined species of *Neoaplectana* were obtained from them in Alabama, Florida

and Mississippi, though they occurred in appreciable numbers in only the Gulfport area of Mississippi, where there appeared to be a complex of species or varieties. Parasitism by native Mermithids, one of which was determined as *Hexamermis* sp., was also found in Mississippi and Alabama, and by another Nematode, which is unlike *Neoaplectana* but develops similarly in the host, in Mississippi, Louisiana, Alabama and Florida. One form, referred to as *Neoaplectana* 41035, was cultured on artificial media in the laboratory by the methods used for *N. glaseri*. It exists freely in the soil only as ensheathed larvae, which enter the host insect, presumably by way of the mouth or anus, and penetrate into the body cavity, where they mature. There are two sexes and the females are ovoviviparous. The host insect dies 2–3 days after becoming parasitised, and the Nematode then reproduces in its dead body until all available nourishment is exhausted, after which the larvae are ready to break out into the soil and find a new host. If one is not available, they can remain alive in the soil for an indefinite period. The life-cycle lasts about a week at 72°F., and more than a thousand Nematodes can be produced in a single large host larva. It is believed that only the stages of the weevils that live in the soil are subject to attack by *Neoaplectana*, but the Nematode has been observed in adults leaving the soil, and may possibly be distributed above ground by them. This species gave about the same degree of control of test insects as *N. glaseri*, which readily attacked *Pantomorus peregrinus*, Buchanan, and *P. leucoloma*, Boh. With a period of exposure of not more than four weeks, mortality of larvae or pupae of the weevils averaged 58, 78 and 91 per cent., respectively, with dosages of one, five and ten thousand Nematodes per ounce of soil in the laboratory and 44–99 per cent. for dosages of 15, 75 and 1,500 per ounce of soil in outdoor cages. Field plots treated with the two Nematodes at the rate of 25,000 per sq. ft. were established in infested soil in Louisiana, Mississippi, Alabama and Florida during the spring of 1942, and preliminary sampling has resulted in the recovery of Nematode larvae from the soil of half the plots. The Gulfport species of *Neoaplectana* have also been taken in Lamellicorn larvae and on one occasion in a pupa of *Listroderes obliquus*, Gylh., and attacked *L. obliquus*, an undetermined species of *Curculio*, *Pantomorus taeniatulus*, Berg, and *Cylas formicarius* var. *elegantulus*, Summers, in the laboratory. *Neoaplectana chresima*, another Nematode parasite of *Popillia japonica*, was also found to attack *Pantomorus peregrinus*, and *Neoaplectana* 41035 was tested against *P. japonica* in New Jersey and attacked it in the laboratory and in field plots.

CHAMBERLIN (T. R.), FLUKE (C. L.) & CALLENBACH (J. A.). **Species, Distribution, Flight, and Host Preferences of June Beetles, in Wisconsin.**—*J. econ. Ent.* **36** no. 5 pp. 674–680, 4 figs., 4 refs. Menasha, Wis., 1943.

An account is given of investigations carried out to discover which species of *Lachnosterna* (*Phyllophaga*) are the most prevalent in Wisconsin, their flight habits and food preferences and the relative importance of the broods, in order to determine whether they can be controlled by insecticidal treatment of the food-plants of the adults and when such control is possible. In 1935–41, 56,344 beetles belonging to 18 species were collected from plants in woodland, chiefly in the south of the State; *L.* (*P.*) *rugosa*, Melsh., *L.* (*P.*) *hirticula*, Knoch, and *L.* (*P.*) *fusca*, Froel., which together comprised 87·93 per cent. of the total taken, *L.* (*P.*) *implicita*, Horn, *L.* (*P.*) *tristis*, F., and *L.* (*P.*) *ilicis*, Knoch, predominated, and grubs of *L. rugosa*, *L. hirticula*, *L. fusca* and *L.* (*P.*) *futilis*, Lec., were the commonest in cereal and forage crops. Although influenced by soil temperatures and other factors, emergence of the beetles from the soil was highest when the air temperature was 65°F. or above. Early in the season, emergence began at about 7.30 p.m., but towards the end of the season, as the days got longer, at about 8.20 p.m. Emergence began earlier on cloudy evenings than on others. The importance of the flights of different broods is discussed,

and the chief food-plants are shown in tables; of these, hazel [*Corylus*], bur oak [*Quercus macrocarpa*] and hickory are the most important and if the destruction by poison of considerable numbers of beetles in any locality is attempted, hazel brushwood as well as trees must be treated. The control of the adults by spraying or dusting would be difficult when *L. rugosa*, *L. fusca* and *L. futilis* are the predominating species, since these have ten, eight and twelve principal food-plants, respectively, but less difficult when *L. hirticula*, *L. tristis*, *L. implicita* and *L. ilicis* are concerned, since these tend to feed on a smaller variety of plants.

CHAMBERLIN (T. R.) & CALLENBACH (J. A.). **Oviposition of June Beetles and the Survival of their Offspring in Grasses and Legumes.**—*J. econ. Ent.* **36** no. 5 pp. 681–688, 2 figs., 9 refs. Menasha, Wis., 1943.

Observations over several years in southern Wisconsin having confirmed that the larvae of *Lachnosterna* (*Phyllophaga*) are commonly more numerous in fields of grass than in leguminous plants, experiments to determine whether the females would oviposit as freely in leguminous crops as in grass and whether the rates of survival of the larvae in them were different were carried out in 1940, 1941 and 1942 with blue-grass [*Poa*], one of the crops most favourable for oviposition and larval survival, and sweet clover [*Melilotus*], one of the least favourable. The blue-grass was natural growth, and the sweet clover was sown in the spring of the year in which the tests were begun. Cages enclosing about 4 sq. ft., with sides 8 ins. high, were set into the soil to a depth of 4 ins., and covered with muslin or surgical gauze, which resulted in poor ventilation, in the earlier experiments, and with 14-mesh screen in the later ones, before the flight of the beetles began. When flights had become heavy and it was estimated that oviposition was about to begin, equal numbers of females and, where possible, of males were put in the cages. The resultant populations in the soil were determined by digging in August and late September or October of the first year, in June, September and October of the second year, and in June and July of the third year in some cases, though it was found that mortality was heaviest in the first year and was sometimes so great as almost to eliminate the larvae in the plots of sweet clover. In 1940 and 1941, *L.* (*P.*) *hirticula*, Knoch, and *L.* (*P.*) *rugosa*, Melsh., which had been the most abundant in field crops since 1935, were used; in 1942 it was necessary to use *L.* (*P.*) *implicita*, Horn, in most of the cages and some tests were made on lucerne as well as the other crops, but the resultant infestation was so low that the study was discontinued. The results obtained indicated that although fewer eggs are usually laid among deep-rooted leguminous plants, the beetles sometimes oviposit as heavily in sweet clover as in blue-grass or even more so, but mortality is much greater in the former, especially during the first year, probably because the soil does not retain moisture to any considerable depth, except in periods of more or less continuous rainfall, and contains no compact mat of fine roots unless it is invaded by grass [*cf. R.A.E.*, A **31** 466]. When established, a moderate number of second- or third-instar larvae can probably live very well in plots of leguminous plants, particularly if the crop is not clean; it is known that roots of lucerne and sweet clover are acceptable to second- or third-instar larvae, because new plantings of these crops on land already heavily infested with second-year grubs are sometimes severely injured by them.

It is therefore concluded that the use of deep-rooted leguminous plants for permanent pasture or hay crops or in rotation will keep grub populations at a minimum. In rotations, prevention of damage would be most effective if as much land as possible were under deep-rooted leguminous crops in the years when major flights of beetles occur.

KULASH (W. M.). **The Ecology and Control of Wireworms in the Connecticut River Valley.**—*J. econ. Ent.* **36** no. 5 pp. 689–693, 8 refs. Menasha, Wis., 1943.

Limonius agonus, Say, is the principal wireworm pest in the Connecticut River Valley near Northampton, Massachusetts. This Elaterid, which inhabits the alluvial soils common to the region, particularly in fields bordering the river, was found to be more abundant in fields that had been cultivated for several years than various species of *Ludius*; *Melanotus* spp. were commoner in sod and grass land. Members of all three genera, however, are injurious to crops, including potatoes, tobacco and market-garden vegetables, especially root crops such as beets, carrots, radishes and onions. The abundance of wireworms at different times of year was estimated by means of soil samples taken to a depth of 12 ins. in plots 2–4 acres in extent. The numbers per cu. ft. in May to mid-June, July to late August, including the time of the potato harvest, and late August to late September, respectively, averaged 7·3, 5·4 and 3·7 in 1940 and 6·3, 5·8 and 4 in 1941, and their average depths were 4·6, 7 and 8·7 ins. in 1940 and 7·5, 7·4 and 9·3 ins. in 1941. In spring, when they were nearest the surface, they were migrating upwards to feed on the roots of newly planted crops, whereas in summer and autumn they were moving downwards. They were most abundant in low-lying and wet areas; and populations were approximately 74 per cent. greater and the average depth in the soil 2 ins. lower in cultivated ground than in sod. The wireworms were also much more abundant in plots that had been under potatoes for five consecutive years than in those that had been under market-garden crops, probably because crop residues were removed from the latter in autumn, and they bore no winter crop and were cultivated much more frequently.

The control of wireworms with dichlorethyl ether, applied to the surface of the soil as a dilute emulsion in water, was found to be limited by poor penetration into the soil. In plots of market-garden vegetables, where the soil was packed by frequent weeding and cultivation, wireworms were seldom killed below a depth of 4 ins. by the maximum surface applications considered practicable. In the loose soil of potato hills, an emulsion containing 0·225 per cent. dichlorethyl ether, applied at the rate of 1 U.S. quart per hill, killed wireworms to a depth of 12 ins., but the treated areas were reinfested within six days, indicating that the emulsion does not remain repellent to wireworms for long. Moreover, it sometimes caused premature yellowing of the potato foliage, resulting in smaller yields, and imparted a disagreeable flavour to the tubers.

Sulphur and tobacco stems broadcast and disked under in autumn and spring, respectively, did not reduce the wireworm populations.

LIST (G. M.). **The Effects of Sulfur Residue on Keeping Qualities of Canned Tomato Products.**—*J. econ. Ent.* **36** no. 5 pp. 694–700, 3 figs., 12 refs. Menasha, Wis., 1943.

Control of *Paratrioza cockerelli*, Šulc, is essential for successful tomato production in most parts of Colorado, and dusting sulphur, wettable sulphur and lime-sulphur are the most effective materials to use [*cf. R.A.E.*, A **29** 21, etc.]. Since, however, a residue of elemental sulphur on the fruit might hasten spoilage in canned products [*cf.* **28** 489] and it is sometimes advisable to spray or dust after the fruit is well formed, tests of the effect of sulphur residues were carried out. The plots were treated with dusting sulphur at the rate of 110 lb. per acre 13 days before the first picking and at 25 lb. per acre on the day before the second picking (21 days after the first treatment) or with a spray of 5 U.S. quarts lime-sulphur and 5 lb. wettable sulphur per 100 U.S. gals. water at 103 and 92 U.S. gals. per acre, respectively, on the same dates, and controls were taken for each treatment and date. At the factory,

the fruit was washed and the juice was extracted and canned under commercial conditions; only this product was tested, as the fruit is not peeled in its preparation and would therefore be most likely to carry injurious amounts of sulphur. Dusting sulphur was added to some cans at the rate of 2, 4, 6 and 10 parts per million parts of can content just before they were sealed. The temperature of the juice at the time of sealing was approximately 180°F. and the cans were stored at 72 and 98°F. and examined at intervals of three months over a period of two years.

Much of the non-bacterial spoilage of canned fruit is caused by corrosion of the tin plate of the cans by fruit acids; hydrogen is produced and the vacuum is consequently lost. The presence of other materials may affect corrosion, but the observations showed that increasing the storage temperature from 72 to 98°F. was a much greater factor in vacuum loss than the addition of 2, 4, 6 or 10 p.p.m. of sulphur, the effect of storage at 98°F. being more than six times that at 72° in the case of cans carrying known amounts of sulphur and almost seven times that at 72° for the field-plot material. Increases in the amount of sulphur added resulted in an increase in the rate of vacuum loss at 72°F., but the loss was not serious for additions of up to 6 p.p.m. It is calculated that at 98°, a complete loss of vacuum can be expected after $2\frac{3}{4}$ years when 10 p.p.m. of sulphur is added and after $3\frac{3}{4}$ years when 6 p.p.m. is added. At both temperatures, the field treatments appeared to have a negligible effect and the data indicated that the use of two applications of sulphur dust or lime-sulphur with wettable sulphur, even after harvest has begun, does not involve any risk from sulphur residues if the usual care in washing the fruit is taken, so that the present general practices of Psyllid control on canning tomatos may safely be continued.

WILCOX (J.). **Rate of Application and Strength of Cryolite Dust Mixtures in Tomato Fruitworm Control.**—*J. econ. Ent.* **36** no. 5 pp. 700–705, 2 refs. Menasha, Wis., 1943.

During experiments carried out in southern California since 1937 on the control of *Heliothis armigera*, Hb., on tomato by cryolite dusts, it was found that the economic value of the treatments varied according to the percentage of damage, the value of the crop and the cost of the insecticide and its application. These factors and their interrelationship are discussed, and the following is based on the author's conclusions. Undiluted cryolite (90 per cent. sodium fluoaluminate) was more effective than 70 per cent. cryolite when an equal amount of dust was applied per acre, but was approximately of the same effectiveness as 35, 50 and 70 per cent. dusts when equal amounts of sodium fluoaluminate were applied. The effectiveness of a 70 per cent. cryolite dust applied at 30, 60, 90, 120 and 150 lb. per acre was correlated with the rate of application, but the differences in control were not great, and the higher rates would in many cases not be justified by the value of the crop saved. Since the percentage of fruits damaged by *Heliothis* may range from 5 to 25, and the value of the crop may range from $50 to $800 per acre, the potential crop loss may range from $2·50 to $200 per acre, and the most profitable rate of application will vary accordngly. When the potential crop loss in dollars per acre is less than 7·5, no treatment seems to be justified, and when it is 10–20, 30, 40–70 and 80–200, the most profitable rates of application for 70 per cent. cryolite are 30, 60, 90 and 150 lb. per acre, respectively. Except under conditions of very light infestation, 90 lb. per acre is generally the most economical rate to use in southern California.

Three applications of 70 per cent. cryolite dusts at intervals of two weeks are not quite so effective as six applications at weekly intervals, but are more economical.

Bailey (S. F.) & Keifer (H. H.). **The Tomato Russet Mite, *Phyllocoptes destructor* Keifer : its present Status.**—*J. econ. Ent.* **36** no. 5 pp. 706–712, 3 figs., 11 refs. Menasha, Wis., 1943.

An account is given of the bionomics and control of *Phyllocoptes destructor*, Keifer, in California, where it is spreading rapidly and is the most serious pest of tomato, though it was probably introduced not long before it was first observed in 1940 [*cf. R.A.E.*, A **29** 565]. All stages and the injury it causes to tomato are described. It also occurs on tomato in Australia and probably in Spain and on tomato and *Solanum nodiflorum* in Hawaii. Its food-plants in California [*cf.* **30** 363 ; **31** 474] include petunia, potato, nightshade (*S. nigrum* and *S. villosum*), *Physalis ixocarpa*, *Datura stramonium* and *D. ferox*, of which the last three are annuals. The mites are rarely found in the flowers of tomato and do not injure them ; they attack the fruit only when infestation is very severe, though they commonly occur on the unripe fruits. The principal commercial injury is from the loss of foliage, which results in sunburning of the lower fruit. Injury spreads rapidly as the season progresses, and the population reaches its maximum in late September. Nearly half the crop is frequently lost in severely infested fields, and total loss may occur if no control measures are taken. Reproduction takes place continuously in the field from early May until November or until frost occurs. During winter, all stages may be present on greenhouse tomatos and on the leaves of protected nightshade plants out of doors in the Sacramento Valley, but the mites are sluggish, and the population is usually small. Very low survival in spring, however, may result in severe infestation by late summer. In laboratory experiments, adults and second-stage nymphs survived exposure for ten days to a constant temperature of 34°F., though nearly all the first-stage nymphs and about half the eggs were killed. At 22°F., mortality was complete in four days. Adults survived starvation for four days in summer ; submergence in water gave compete mortality in 12 hours. The eggs are deposited irregularly, usually among the hairs or in slight crevices on the leaves or stems, but sometimes on the fruit. Eggs deposited by unfertilised females produce only males, but a single female may found a new colony, being fertilised by its male progeny. Counts of four colonies showed a sex ratio of 64 males to 36 females. The mites move from injured dry parts of the plant to fresh green surfaces by crawling, and are carried to other plants by the wind or irrigation water or on tools or clothing.

The principal natural enemy appears to be a predacious Gamasid mite, which feeds on all stages. It keeps *P. destructor* under control in small gardens, but is too scarce in commercial fields to prevent the growth of large populations. *Leptothrips mali*, Fitch, also preys on *P. destructor*, but seldom occurs on tomato plants. A predacious Cecidomyiid larva was occasionally seen among the mites. The most effective method of control is dusting with sulphur [*cf.* **30** 363]. Dusting after mid-September is seldom justified, as most of the injury has by then been done and cooler weather slows down the reproduction of the mite and lessens the danger to the fruit from sunburning. Cultural control and plant-bed management appear to be of little use ; dusting the plants with sulphur in the beds before planting them out might be of some value, but would give reduced protection as the plant grew and possible wind-blown mites infested the fields.

Scott (L. B.) & Milam (J.). **Isoamyl Salicylate as an Attractant for Hornworm Moths.**—*J. econ. Ent.* **36** no. 5 pp. 712–715, 1 fig., 4 refs. Menasha, Wis., 1943.

Protoparce sexta, Joh., and *P. quinquemaculata*, Haw., attack tobacco wherever it is grown in the United States, and are particularly injurious in the

south. The moths are attracted from a considerable distance by the odour of the blossoms of jimson weed (*Datura stramonium*) [*cf. R.A.E.*, A **27** 232], and tests carried out for a number of years in Tennessee have shown that they are also attracted by the odour of isoamyl salicylate, diffused from a small sack of fullers' earth, a disk of plaster of paris or a piece of lampwick and visually by a moth feeder [*cf.* **21** 245] in which a cluster of jimson weed blooms is simulated by three small white tin funnels inserted in the cover of a green can. The feeder, used in conjunction with one of the means of diffusing isoamyl salicylate will attract the moths into a trap consisting of a frame covered with wire screening and equipped with two inwardly projecting entrance funnels, or poison them if it is filled with a liquid bait containing 10 per cent. sugar combined with 0·04 per cent. rotenone from an aqueous extract of derris or cubé or 5 per cent. tartar emetic. Traps or poison feeders destroy enough moths to cause decided reductions in infestation of tobacco, but the results of experiments in 1941 and 1942 indicate that they do not give sufficient protection when infestation is heavy. There was practically no difference in the effectiveness of the two methods. It is concluded that either is valuable as a supplementary control measure and suggested that plantings of less than an acre should be protected by at least two traps or feeders and larger ones by at least two per acre, preferably at the edge of the planting far enough away to permit cultivation. They are more effective on the upper side of a slope, as the odour of the isoamyl salicylate tends to diffuse down it.

McGarr (R. L.) & Henry (J. R.). **Insecticide Tests for Boll Weevil and Cotton Aphid Control in the Mississippi Delta.**—*J. econ. Ent.* **36** no. 5 pp. 716–718. Menasha, Wis., 1943.

An account is given of experiments carried out in 1942 on the control of *Anthonomus grandis*, Boh., and *Aphis gossypii*, Glov., on cotton in Mississippi, in which calcium arsenate and a mixture of calcium arsenate and sulphur (1 : 2) were applied alone or with nicotine sulphate or other aphicides ; approximately 5 per cent. hydrated lime was added to the mixtures containing nicotine to ensure its liberation. The dusts were applied at the rate of 6–8 lb. per acre at intervals of 4–5 days when boll weevil infestation exceeded 15–25 per cent. in the plot showing the best control, 4–6 applications being made between the middle of July and the middle of August.

Calcium arsenate with 2 per cent. actual nicotine in alternate applications and calcium arsenate with 1 per cent. in all applications gave satisfactory control of the weevil, kept the Aphid infestation about the same as in untreated plots and resulted in increases in yield of seed cotton of 415 and 394 lb. per acre, respectively, in large-plot tests, and 323 and 318 lb. per acre, respectively, in small plots, whereas calcium arsenate alone controlled the weevil but resulted in a loss of 138 lb. per acre in the large plots and a gain of only 11 lb. in the small ones. The yields for no treatment were 2,132 lb. per acre in large plots and 1,912 in small ones. The differences in yield between the treatments with and without nicotine seemed to be due largely to Aphid damage. In small-scale tests, calcium arsenate alone gave better control of *Anthonomus* than the mixture of calcium arsenate and sulphur, but resulted in the development of significantly more Aphids, in the absence of aphicides. The addition of 1 per cent. Lethane 60 (an insecticide concentrate containing not less than 50 per cent. by volume of β-thiocyanoethyl esters of fatty acids with average carbon contents of 10–18) and 0·5 per cent. actual nicotine in all applications or of 1 per cent. Lethane 60 and 1 per cent. nicotine in alternate applications of the mixture of calcium arsenate and sulphur increased the yield by 163 and 177 lb. per acre, respectively, owing chiefly to Aphid control. These mixtures and calcium arsenate with nicotine gave significantly better Aphid control than calcium arsenate with 0·5 per cent. rotenone from cubé containing 4·1 per cent. rotenone and 18·3 per

cent. total extractives. It is evident, therefore, that the losses in yield due to the increase in Aphids that follows the dusting of high-yielding cotton with calcium arsenate may exceed the gains obtained from control of light to moderate infestations of the boll weevil.

ROARK (R. C.). **Agricultural Insecticides and critical War Materials.**—*J. econ. Ent.* **36** no. 5 pp. 720–724, 6 refs. Menasha, Wis., 1943.

The author discusses the insecticidal importance of a number of materials, the supply of which is restricted in the United States owing to demands for war purposes, and of others available in quantities that permit their use as substitutes for scarcer materials. He emphasises the point that as the supplies available change rapidly, it is important to have several materials for the control of any given insect and that attention should be given to synthetic compounds, most of which are made from materials that are abundant.

TURNER (N.). **Reversals in Order of Effectiveness of Insecticides.**—*J. econ. Ent.* **36** no. 5 pp. 725–728, 3 figs., 7 refs. Menasha, Wis., 1943.

As various workers have obtained inconsistent results in comparisons of the relative effectiveness of derris dust and dual-fixed nicotine dust for the control of the European corn borer [*Pyrausta nubilalis*, Hb.], maize planted in Connecticut on 17th April was dusted on 10th, 16th, 20th and 25th June with mixtures of derris and clay containing 0·25, 0·5, 1 and 2 per cent. rotenone or with dual-fixed nicotine in clay prepared to contain 1, 2, 4 and 8 per cent. nicotine. Most of the plants were in the mid-whorl stage at the time of the first application and the late tassel stage when treatment was completed ; the peaks of egg deposition and hatching occurred on about 13th and 19th June, respectively. Dosage-response curves plotted to compare the reduction in numbers of larvae in the whole plants and in the ears given by the dusts containing rotenone and those containing four times as much nicotine crossed at approximately 0·7 per cent. rotenone and 3 per cent. nicotine for plants as a whole and 0·3 per cent. rotenone and 1·25 per cent. nicotine for ears only, nicotine being more effective than rotenone above these points and less below. As the point of crossing of the curves for the plants is near the concentrations used in previous single-dosage tests, it is possible that reversals in order of effectiveness have been due to a shift of the point of crossing. It is seldom possible in field tests to determine the amount of insecticide actually effective in protecting the plant, and it is the practice to measure the results in terms of the amount of toxicant delivered from the duster, which is satisfactory in some cases, but ignores volatility and tenacity, which are drastically affected by changes in temperature and rainfall, in others. In a discussion of factors that might affect the point of crossing of the curves when this quantity is taken as the dosage, based chiefly on the literature, it is shown that either a change in slope of the lines or a change in position, which must be greater for one material than the other, may be involved. Since insecticides used against *P. nubilalis* probably act as stomach poisons, the resistance to weathering of the deposits is of importance, and a difference in tenacity of the materials compared would result in a movement of the point of crossing according to the wetness of the season. Laboratory tests indicated that derris dust resisted about six times as much washing as the nicotine material and should therefore perform relatively better in wet seasons.

It is suggested that reversals in order of effectiveness of other insecticides may be due to a similar type of reaction, which would explain logically reversals in different seasons or in different areas in the same season.

Richardson (H. H.). **Toxicity of Derris, Nicotine, and other Insecticides to Eggs of the Housefly and the Angoumois Grain Moth.**—*J. econ. Ent.* **36** no. 5 pp. 729–731, 1 fig., 9 refs. Menasha, Wis., 1943.

The results are given of experiments on the toxicity of derris, nicotine and some of its compounds, and other materials to the eggs of *Musca domestica*, L., and *Sitotroga cerealella*, Ol. The eggs were dipped for 10–12 seconds in a test tube containing the material, usually in a solution or suspension, and then kept in petri dishes. Against house-fly eggs 1½–5 hours old, suspensions of derris powder, derris extract or rotenone were most effective. The suspensions of the powder and extract appeared to be fairly stable and derris powder apparently contained water-soluble materials toxic to the eggs in addition to the small quantities of soluble rotenone ; the marc remaining after one water extraction was still toxic. Extracts from *Tephrosia piscatoria* and *T. virginiana* were also toxic. Pyridine, pine oil, oil derived from the dry distillation of various plants and a thiocyanate mixture were effective when the petri dishes in which the treated eggs were kept were covered, but not when they were open, indicating a fumigating action. The pyrethrins, anabasine, nicotine and its compounds and petroleum oil showed little toxicity, but nicotine was more effective against eggs 1–2 hours old.

Against *S. cerealella*, pyrethrins I and II at a concentration of 0·007 per cent. were much more toxic than nicotine or nicotine sulphate at 0·07 per cent. or derris extract containing 0·001 per cent. rotenone, in the early stages of incubation, but all these materials were very effective against older eggs.

Mason (A. C.), Chisholm (R. D.) & Burgess (E. D.). **Ethylene Dichloride Treatments for the immature Stages of the Japanese Beetle.**—*J. econ. Ent.* **36** no. 5 pp. 734–737, 2 refs. Menasha, Wis., 1943.

An account is given of experiments on the use of low dosages of ethylene-dichloride emulsion as a dip for the control of immature stages of *Popillia japonica*, Newm., in soil about the roots of plants, as a result of which a method for the treatment of balled and potted plants with this emulsion was developed and authorised by the United States Department of Agriculture [*cf. R.A.E.*, A **31** 256]. Immersion of the roots in balls or pots as large as 10 ins. in diameter for 10 seconds in an emulsion of 1 gal. emulsible mixture [*cf. loc. cit.*] to 100 gals. water resulted in mortality of all larvae, most of the pupae and at least one-third of the eggs, and the effectiveness of the treatment was not reduced by variations in temperature, moisture, ball wrapping and soil type such as commonly occur in nurseries. Incidental observations on other Lamellicorn larvae indicated that *Aserica* (*Autoserica*) *castanea*, Arr., *Strigoderma arboricola*, F., and some species of *Lachnosterna* (*Phyllophaga*) were more resistant than *Popillia japonica* to ethylene dichloride.

Applications of the dilute emulsion to the surface of the soil about the roots of plants growing in beds or to turf, at the rate of 2 U.S. gals. per sq. yard, killed all the larvae of *P. japonica* present and a high percentage of the pupae ; half this quantity was very effective on turf. Injury to plant growth by these treatments was negligible.

As a fumigant in an enclosed chamber, a mixture of ethylene dichloride and carbon tetrachloride (3 : 1) gave promising results against *P. japonica* in preliminary trials. All larvae, including some in pots or soil balls, were killed by exposure for 3 hours to 1½ lb. per 1,000 cu. ft. at 70 or 80°F. or 3 lb. at 60°. The dosage required below 60° injured some of the azalea plants used.

English (L. L.). **Fumigations of Camellias and Azaleas with Methyl Bromide.** —*J. econ. Ent.* **36** no. 5 pp. 737–743, 3 figs., 8 refs. Menasha, Wis., 1943.

The following is based largely on the author's summary. The effectiveness of methyl bromide against *Lepidosaphes camelliae*, Hoke, and *Fiorinia theae*,

Green, on *Camellia* was studied over a temperature range of 60–110°F. and with dosages of 0·5–4 lb. per 1,000 cu. ft. in gas-tight chambers. The relationship between the dosage and exposure requirements for a perfect kill of these scale insects was found to be logarithmic at constant temperature, and the relationship is approximated by the equation $DE = C$, where D is the dosage in lb. per 1,000 cu. ft., E the exposure in hours and C a constant. Furthermore, DE was found to be an exponential function of temperature, and the relationship is approximated by the equation $DE = 40{\cdot}23e^{-0{\cdot}030T}$, where T is the temperature in degrees Fahrenheit. A nomograph is given for obtaining the relationship of the three variables.

The margin between the requirements for a perfect kill of the scale insects and injury to the food-plant decreased as the fumigation temperature increased [*cf. R.A.E.*, A **30** 492]. This margin of safety was sufficient to permit practical fumigation of *Camellia* and azalea at any desired temperature from 60 to 100°F., provided that the plants were shaded for at least 24 hours after fumigation. The plant tolerance limits were also approximated by exponential equations and a nomograph is given for estimating these limits. Of the many varieties of *Camellia* that were fumigated, none was particularly susceptible to methyl bromide. Two varieties of azalea of 79 tested apparently cannot be fumigated. Fumigation schedules and a procedure for the commercial treatment of plants were developed. Recommended schedules are 3 lb. per 1,000 cu. ft. for 3 hours at 60°F., and 2 lb. for 3½ hours at 70°F., 2½ hours at 80°F. and 1½ hours at 90°F.

In tests with other pests, 2 lb. per 1,000 cu. ft. for 2 hours at 80°F. gave complete kill of *Paratetranychus ilicis*, McG., on *Camellia* and *Eriococcus azaleae*, Comst., on azalea; 2 lb. for 1½ hours at 80°F. and for 1 hour at 90°F. gave complete kill of *Stephanitis pyrioides*, Scott, including the eggs in the leaf tissue of azalea; and 2 lb. for 1½ hours at 90°F. was required to kill all stages of *Heliothrips haemorrhoidalis*, Bch., on azalea foliage.

Yust (H. R.), Nelson (H. D.) & Busbey (R. L.). **Comparative Susceptibility of two Strains of California Red Scale to HCN, with special Reference to the Inheritance of Resistance.**—*J. econ. Ent.* **36** no. 5 pp. 744–749, 1 fig., 10 refs. Menasha, Wis., 1943.

The following is substantially the authors' summary. A study of strains of *Aonidiella aurantii*, Mask., that differed in susceptibility to fumigation with hydrocyanic acid was begun in the summer of 1934. Scales differing widely in susceptibility, obtained from two sources in California, were placed in adjacent isolated compartments in the insectary and reared on potted lemon trees for the duration of the investigations. Throughout a period of more than six years there was a consistently higher kill of the non-resistant strain than of the resistant one when the two were fumigated simultaneously. A difference in mortality occurred in each of the developmental stages tested and in both sexes. There was no evidence that the difference in susceptibility between the two strains had either increased or decreased over this period of time. The difference was not due to permeability of the wax covering, although removal of this prior to fumigation increased the kill.

Five generations of the hybrid stocks obtained from reciprocal crosses of the resistant and non-resistant strains were fumigated, and the mortality was compared with that resulting from fumigation of the corresponding generation of the resistant and non-resistant strains. In the F_1 generation of the reciprocal crosses the males were like the female parent with regard to susceptibility, suggesting that the gene for resistance is a sex-linked character, but the females were more like the resistant than the non-resistant strain, suggesting that resistance is incompletely dominant. Further crosses, recrosses and back-crosses that were made confirmed these results.

Repeated fumigations of successive generations of the resistant strain were followed by an increase in relative resistance to fumigation, and similarly the susceptibility of the non-resistant strain was decreased somewhat by a single fumigation, indicating that non-resistant scales were present in the resistant strain used, and that probably insects resistant to fumigation were also present in the non-resistant strain used [*cf. R.A.E.*, A **32** 9].

NELSON (H. D.). **The Position of the Rostralis of the California Red Scale feeding on Lemons.**—*J. econ. Ent.* **36** no. 5 pp. 750–751, 2 figs. Menasha, Wis., 1943.

The following is the author's summary. This paper reports the results of a study of the position of the rostralis of various stages of the California red scale [*Aonidiella aurantii*, Mask.] when feeding in the tissue of lemon fruit. It was observed that the average length of the rostralis increased appreciably with each stage of the insect and that scales of each stage fed at different levels in the rind. The path of the rostralis through the rind was found to be irregular. The tip of the rostralis was always located within a cell of the host tissue. There was marked injury to the cells in which second- and third-stage scales were feeding.

ISELY (D.) & HORSFALL (W. R.). **Effect on arsenical Deposits of accessory Materials in the Spray Mixture.**—*J. econ. Ent.* **36** no. 5 pp. 751–756, 10 refs. Menasha, Wis., 1943.

When lead arsenate is sprayed on apples for control of the codling moth [*Cydia pomonella*, L.], it is nearly always mixed with other materials such as fungicides, safeners (to reduce the possible injury to the tree by water-soluble arsenic) or spreaders and adhesives. Because of uncertainty regarding the effect of these accessories in the spray mixture, preliminary experiments were carried out in Arkansas to measure by chemical analysis the amount of arsenic deposited on leaf surfaces by spraying with lead arsenate alone and in combination with other materials; no attempt was made to measure either the relative duration or insecticidal efficiency of the various deposits. The materials studied comprised fungicides, including Bordeaux mixture, wettable sulphur and lime-sulphur; hydrated lime, commonly added to reduce the possibility of arsenical injury to foliage; talc, which was used to determine the effect of a presumably inert powder; and one white-oil emulsion and various other adjuvants commonly used. They were added to the spray mixture at the rate commonly employed by fruit growers, or at that directed by manufacturers in the case of the proprietary adjuvants. The sprays were applied to the primary leaves of lima bean, and, when the deposits had dried thoroughly, the leaves were removed for analysis of the arsenical residue. A commercial brand of lead arsenate, at a concentration of 3 lb. per 100 U.S. gals., was used as the standard, with which mixtures including the same concentration of lead arsenate and one of the materials to be tested were compared.

No material increased the initial deposit of arsenic, and only Bordeaux mixture (2 : 3 : 100) appeared not to affect it adversely; Bordeaux mixture (6 : 6 : 100) was among the materials that affected the deposit least. Spray mixtures containing talc left a smaller deposit than the standard, but the difference was within the range required for significance. Of the powders tested, those that were added to increase spreading reduced the deposit most, the amount of arsenic deposited by such mixtures ranging from 43·8 per cent. of the standard by one including a proprietary adjuvant, to 79·22 by one including 8 oz. soy-bean flour. Hydrated lime affected the deposit less than any of the powdered adjuvants. Wettable sulphur, which is not added to improve spreading, but includes a spreader, resulted in an arsenical deposit similar to those from

the common adjuvants. Increasing the quantities of lime or soy-bean flour resulted in decreased deposits, but the differences were not significant. Summer oil did not increase the initial deposit of arsenic on an oil-free leaf, but this might not be true in an orchard where successive applications were made, and lead arsenate may resist weathering better when applied with summer oil than when applied alone. The standard lead arsenate contained a small amount of added material, and the same lead arsenate to which nothing had been added gave deposits 6·4 per cent. greater. Increasing the amount of lead arsenate in a spray mixture increased the total deposit of arsenic, but not in proportion to the total amount applied. The reduction in percentage deposit was similar to that of mixtures in which other powders are added, the deposit decreasing as the total solids in the mixture are increased. Those from sprays containing 4 and 6 lb. per 100 U.S. gals. water were 51·14 and 89·45 per cent. greater than that from one containing 2 lb.

Additional analyses of deposits on apple foliage in the greenhouse and orchard showed that the relative proportion of arsenic deposited by various spray mixtures was similar to that on bean foliage, but the run-off and the differences between various mixtures were less. The deposit of arsenic when liquid lime-sulphur was added at the rate of 3 : 100 averaged 73·65 per cent. of that obtained from lead arsenate alone.

Possible explanations of the results obtained and the questionable value of many materials added to arsenical sprays are discussed [*cf. R.A.E.*, A **31** 338], and the results are given of miscellaneous analyses of arsenical deposits on fruit and foliage collected during two seasons in commercial apple orchards and in blocks sprayed experimentally. From these it is concluded that the variation in personal efficiency of spray crews has a much greater effect than any variation in materials added to lead arsenate and may completely obscure any differences caused by accessory materials in the spray mixture.

ISELY (D.). **Early maturing Varieties in Codling Moth Control.**—*J. econ. Ent.* **36** no. 5 pp. 757–759, 1 ref. Menasha, Wis., 1943.

The following is based on the author's summary. The codling moth [*Cydia pomonella*, L.] has three main generations a year in north-western Arkansas, although a few larvae of the first generation and about 15 per cent. of the second overwinter ; there is also a partial fourth generation. There is little injury to varieties of apple that are harvested by the time larvae of the second generation are beginning to hatch (about 1st July), provided that they are isolated from later varieties. Under such conditions, the late generations, on which infestation in the succeeding season depends, cannot develop. In orchards of early summer apples isolated from late apples, there is no problem of control. In orchards where early varieties are interplanted with early or late autumn varieties, control may be difficult, since the late generations can survive to the end of the season in late varieties of apple and enter hibernation in the orchard. Early as well as late varieties are exposed to infestation by the overwintered generation, and early ripening fruit in infested orchards is particularly susceptible to injury.

Early autumn varieties that ripen before most of the third-generation larvae have left the fruit, if grown in blocks separate from later varieties, are less difficult to protect than late autumn varieties, but require adequate spraying. Mixing early and late autumn varieties makes control much more difficult.

In view of the great importance of *C. pomonella* to apple production in the southern apple-growing regions, varieties that are harvested at the same time should be grouped together when commercial orchards are planted. Such grouping makes control less difficult and reduces spraying costs. Early production as a means of control may be even more useful in home orchards, which

are generally inadequately sprayed, and, when composed of mixed plantings, tend to produce no good fruit.

BAKER (H.). **Orchard Tests of chemically treated Bands for Codling Moth Control in the Missouri River Valley.**—*J. econ. Ent.* **36** no. 5 pp. 760–764, 7 refs. Menasha, Wis., 1943.

An account is given of experiments carried out in Missouri during 1935–38 to determine the amount of chemical coating necessary to ensure the efficiency of treated bands for use in this area against the larvae of the codling moth [*Cydia pomonella*, L.] on apple. Single-face corrugated paper, 2 ins. wide and having 36–40 corrugations per foot, was impregnated with a solution of 1 lb. beta-naphthol in 1½ U.S. pints mineral oil, with the addition of ½ oz. aluminium stearate in some cases when the bands were dipped in the hot solution; cold-dipped bands were prepared by diluting the solution in petrol [*cf. R.A.E.*, A **26** 507]. The prepared bands contained about 0·75–0·2 oz. chemical coating per linear foot. They were applied to the trees in time for larvae of the first generation and examined twice a week until at least a fortnight after the completion of harvest in most cases. Most of the treatments tested were highly effective in reducing moth emergence and few differences between treatments were consistently significant, though there was a tendency for lighter coatings to permit the emergence of more moths than heavier ones. There were greater and more consistent differences between treatments in the number of normal living larvae in the bands at the end of the season, and bands with an initial coating of approximately 0·4 oz. or more per linear foot generally contained a smaller percentage of these than those with lighter coatings. Properly prepared hot- and cold-dipped bands were equally effective, and the grade of beta-naphthol (technical or crude) and the viscosity of the oil (100 or 300 secs.) did not affect their efficiency. Aluminium stearate improved the efficiency of the hot-dipped bands in some cases, probably by aiding in the retention of the coating during excessive rainfall or high temperatures. Chemical analysis indicated that the loss of coating from bands during a period of three months is very heavy, regardless of the method or materials used in their preparation. The percentage loss of beta-naphthol is also heavy and may be greater or less than the percentage loss of total coating, being greater from the lighter than from the heavier coatings; loss of beta-naphthol was almost complete from all bands with a 0·3 oz. chemical coating per foot. Records of the rate and degree of loss of coating, obtained by weighing the bands, showed that the loss was heaviest during the first month of exposure, significant further losses occurred as the period of exposure increased and losses were usually significantly greater from bands with the heavier coatings.

SNAPP (O. I.). **Propylene Dichloride for Peachtree Borer Control.**—*J. econ. Ent.* **36** no. 5 pp. 765–768. Menasha, Wis., 1943.

The following is based largely on the author's summary. Experiments with propylene-dichloride emulsion, prepared by the cold-stirred method from a 30 per cent. solution of potash fish-oil soap and propylene dichloride (1 : 9), for the control of *Aegeria* (*Sanninoidea*) *exitiosa*, Say, in peach trees were begun in Georgia and Maryland in 1941. In Maryland, the emulsion, applied at the same strength and rate as recommended for ethylene-dichloride emulsion (½ U.S. pint of 15 per cent. emulsion per tree), caused no injury to three-year-old seedlings in silt-loam soil when used at the usual time in the autumn in either very dry or very wet soil and only minor injury when used late in the autumn in wet soil. In Georgia, the emulsion was more toxic to trees up to four years old than ethylene dichloride, but serious injury occurred only when it was applied round two-year-old trees at the same strength and rate as recommended

for ethylene dichloride ($\frac{1}{4}$ U.S. pint of 15 per cent. emulsion per tree). The experiments indicated that good borer control without tree injury can be expected from propylene-dichloride emulsion used at $\frac{2}{3}$–$\frac{3}{4}$ of the rates required for ethylene-dichloride emulsion [*cf. R.A.E.*, A **27** 256], but further tests are needed to determine more definitely the strengths to be used on trees of different ages. In the comparative tests in Georgia, paradichlorbenzene crystals were less effective than either emulsion in controlling *A. exitiosa* in peach trees three years or more old, and caused serious injury to one- and two-year-old trees.

Beal (J. A.) & McClintick (K. B.). **The Pales Weevil in southern Pines.**—*J. econ. Ent.* **36** no. 5 pp. 792–794, 2 refs. Menasha, Wis., 1943.

Adults of *Hylobius pales*, Hbst., which are known to be injurious to young pines in the south-eastern United States [*cf. R.A.E.*, A **9** 288], caused serious damage to young southern pines (*Pinus taeda* and *P. echinata*) in recently cut-over areas in a forest in North Carolina during the summer of 1940. They were also observed on planted conifers, including *P. sylvestris*, *P. palustris*, *P. resinosa*, *Cupressus arizonica*, which was severely damaged, and *Juniperus virginiana*. In this neighbourhood the weevil has one complete generation and a partial second in the year. The adults hibernate under litter, emerge about mid-March and usually begin to oviposit in late March or April, often burrowing deep into the soil to deposit eggs singly in punctures in the bark of the roots of stumps and of dying pines or round the root collar below the ground line. They also oviposit in the inner bark of pine logs, but no successful brood development was observed in such material. The larvae feed singly, making irregular tunnels, and those that overwinter when nearly full-grown pupate in spring and begin to give rise to adults 4–6 weeks after the emergence of the overwintered adults. It appears that eggs laid by June or earlier produce adults that emerge during late summer or early autumn, and those laid later produce the adults that emerge in the following year. The damage is most severe during June and July. The adults hide during the day and feed principally at night, devouring irregular patches of the thin bark on the trunk and branches of pines of all sizes. Seedlings and young pines up to 4–5 ft. in height are most seriously damaged, especially in the vicinity of freshly cut stumps, dying pines or logging or building operations, the weevils being attracted by the odour of pitch and by pines infested by bark-beetles. Although most feeding occurs less than 4–5 ft. above the ground, some has been observed on branches as much as 35 ft. from the ground. In tests in which seedlings of *P. taeda* and *P. echinata* were grown on ground cleared in 1937, and additional pines were removed round the edges of the clearings in the winter of 1939, weevils that were attracted to the stumps of the latter during the following spring and summer fed heavily on the young pines, and killed numbers varying directly with the number of available seedlings and inversely with the distance from the edge of the clearing.

Young (H. D.) & Cotton (R. T.). **Certain organic Bromides as Grain Fumigants.**—*J. econ. Ent.* **36** no. 5 p. 796, 1 ref. Menasha, Wis., 1943.

In fumigation tests, the minimum lethal dosages of allyl bromide for *Calandra* (*Sitophilus*) *oryzae*, L., were 17 and 1 mg. per litre when the insects were exposed for 1 and 24 hours, respectively, in empty 20-litre bottles and 6 mg. per litre when they were treated for 24 hours in bottles filled with wheat. The corresponding dosages for *Tribolium confusum*, Duv., were 23, 3 and 10 mg. per litre. Ethylene bromide and *n*-butyl bromide were less effective against both species. In large-scale tests in which approximately 2 lb. allyl bromide made up to 2 U.S. gals. with carbon tetrachloride was sprayed on to the surface

of 1,000 bushels of wheat in steel bins, test insects at various levels in the grain showed complete mortality after 72 hours. No loss of germination resulted, but a persistent odour in the fumigated grain may prove to be objectionable.

Methyl bromide was found ineffective for fumigating grain in elevators and farm bins until it was mixed at a concentration of 10 per cent. by volume with a diluent to reduce its volatility, but grain was effectively fumigated when a mixture of methyl bromide, ethylene dichloride and carbon tetrachloride (4 : 27 : 9) was used at the rate of 2 U.S. gals. per 1,000 bushels [*cf. R.A.E.*, A **31** 235]. In view of the present demand for large quantities of both these diluents in other industries, mixtures of methyl bromide, propylene dichloride and carbon tetrachloride (4 : 27 : 9) and of methyl bromide and propylene dichloride (4 : 36) were compared with the original mixture in tests against *C. oryzae* and *T. confusum*. The results indicated that the insecticidal values of such mixtures for the treatment of grain vary but little, regardless of the diluent used [*cf. loc. cit.*].

Chamberlin (T. R.) & Fluke (C. L.). **DN Sulfur Dust appears effective against the Sweetclover Weevil.**—*J. econ. Ent.* **36** no. 5 p. 797. Menasha, Wis., 1943.

In Wisconsin, adults of *Sitona cylindricollis*, Fhs., attack the new growth of second-year plants of sweet clover (*Melilotus* spp.) as soon as it appears in spring, considerably retarding it, and may completely destroy the new seedlings, which appear later. In tests of various dusts applied to plants 2–6 ins. high in the spring of 1943, only 0·8 per cent. dinitro-o-cyclohexylphenol in sulphur gave good kills (approximately 96·6 per cent. as determined by collecting live and dead weevils on the ground of the plot within 20 hours after dusting). This material apparently acted more rapidly than the others and caused no damage in these tests, though in a footnote the authors state that it subsequently caused slight to moderate injury, chiefly when the dusts were applied later in the season and both humidity and temperature were high. Of the other dusts, undiluted calcium arsenate killed about 50 per cent. of the weevils, barium fluosilicate gave some control, and rotenone (0·75 per cent.) in talc, sulphur or pyrophyllite, nicotine (2 per cent.) in pyrophyllite and pyrethrum in talc (0·2 per cent. pyrethrins) appeared to be useless.

Since the weevils attacked new shoots that were so small as to be found with difficulty, it is possible that the best control may be obtained by applying the dust to the ground while only a few shoots, on which the weevils are concentrating their attacks, are present.

Ambruster (H. W.). **Arsenate of Iron.**—*J. econ. Ent.* **36** no. 5 pp. 798–799, 4 refs. Menasha, Wis., 1943.

The author discusses the possibility of utilising large deposits of scorodite (a ferric arsenate) at Gold Hill, Utah, for insecticides in view of the threatened shortage of arsenic in the United States, either by extracting the arsenic as arsenic trioxide or by micronising the ore itself. He gives a short account of earlier work with ferrous and ferric arsenates as insecticides, and, in spite of contradictory reports, concludes that they have value under some conditions. He states that the toxic qualities of ground scorodite, which has an extremely low water-soluble arsenic content, have been demonstrated in actual tests.

de Ong (E. R.). **Frianite, an Insecticide Diluent.**—*J. econ. Ent.* **36** no. 5 pp. 799–800, 1 ref. Menasha, Wis., 1943.

Volcanic ash obtained from a deposit at Friant, California, is ground, dried and screened to give standard products with particle sizes of 3·5 and 5·65

microns, which are marketed under the trade name of Frianite. Frianite can be used as a base for organic compounds, such as pyrethrum and rotenone solutions that are sensitive to alkaline reactions, as it has a pH value of 6·8–6·9, and as a diluent for powders such as lead arsenate without the danger of forming soluble arsenical compounds, owing to its lack of chemical reaction with them. The rate of release of free nicotine and nicotine from nicotine sulphate was consistently lower from the finer grade (Frianite M3x) than from the coarser one (Frianite D.S.) at temperatures of 50–72°F. and for various exposures, permitting a choice between very rapid and significantly slower rates of nicotine evolution. The average percentages of residual nicotine in the dusts after exposure were 8, 15 and 10 for free nicotine and 31, 41 and 18 for nicotine sulphate when the carriers were D.S., M3x and hydrated lime, respectively.

Davis (A. C.). **Effect of California Buckeye on Ants.**—*J. econ. Ent.* **36** no. 5 p. 800, 1 ref. Menasha, Wis., 1943.

As honey-bees in California are often poisoned by the nectar and pollen of *Aesculus californica*, and alcoholic extracts obtained from it have proved toxic to them, tests were made of the possibility of using such extracts for the control of ants. Alcoholic extracts of the nuts and hulls were dissolved at a concentration of 4 per cent. in a mixture of honey and water (1 : 1) and administered to colonies of ants in cages ; no other food was given. A colony of *Formica fusca* var. *subsericea*, Say, showed no ill effects from extract of the nuts after one month. Two colonies of *Tapinoma sessile*, Say, fed with extract of the hulls were unaffected after 17 days, but three that were given extract of the nuts were severely affected ; in one colony oviposition ceased and all the ants were dead after 16 days, but in another it proceeded normally (though most of the workers were killed or temporarily paralysed) and young in all stages were present 37 days after the first feeding. A colony of *Monomorium pharaonis*, L., showed no ill effects from an extract of the hulls ; this colony and two of *Tetramorium caespitum*, L., that were given access to syrup containing extract of the nuts fed on it readily at first but soon refused to feed.

Under the conditions of these tests, the extract affected only adults, the brood continuing to develop normally, and would therefore be of little value in controlling any of the species used. The active principle of the nectar has not been isolated, but the toxic material seems to be mainly in the nut.

Rosenstiel (R. G.). **The Effect of certain Chemicals on the Cherry Fruit Fly.**—*J. econ. Ent.* **36** no. 5 pp. 800–801, 1 fig., 2 refs. Menasha, Wis., 1943.

An account is given of laboratory tests in which adults of *Rhagoletis cingulata*, Lw., which is a serious pest of cherries in Oregon, were caged with cherry leaves that had been sprayed or dusted with sweetened or unsweetened insecticides or were directly sprayed or dusted with contact insecticides. The most effective (on the basis of time required for 50 per cent. mortality) were sprays containing, per 100 U.S. gals., 4·5 lb. rotenone-bearing root (2 per cent. rotenone), applied to the flies (60 hours), 4 lb. calcium antimony tartrate with 10 per cent. sucrose, applied to the flies (30 hours) or to the leaves (34 hours) and 4 lb. basic copper arsenate with 10 per cent. sucrose and a spreader, applied to the leaves (53 hours) and contact dusts of 1 per cent. 2,4-dinitro-6-cyclohexylphenol in walnut-shell flour (17 hours), and 0·5 per cent. rotenone in diatomaceous earth (26 hours). Sprays of lead arsenate with molasses or sucrose, cryolite with sucrose, and potassium antimony tartrate with molasses, and a dust containing calcium arsenate with or without sucrose were less effective, and sprays of xanthone or phenothiazine with sucrose and a spreader showed no evidence of toxicity. Control flies given water only or 10 per cent. sucrose showed 50 per cent. mortality in 184 and 224 hours.

Sweetening agents caused a noticeable increase in the speed of action of the dusts and sprays with which they were used.

FLANDERS (S. E.). **The Rôle of Mating in the Reproduction of parasitic Hymenoptera.**—*J. econ. Ent.* **36** no. 5 pp. 802–803, 14 refs. Menasha, Wis., 1943.

The following is the author's summary. In those species of parasitic Hymenoptera in which reproduction is uniparental, mating may cause a reduction in the number of viable eggs. Where reproduction is biparental, mating is necessary only for the production of females. In species in which oviposition occurs as readily before as after mating, the time of mating determines the sex ratio. In species in which mating precedes oviposition, the completeness of oviposition and, consequently, the amount of absorption and the proportion of sterile eggs deposited are determined by the mating. In some cases inbreeding may reduce the proportion of viable fertilised eggs.

LINSLEY (E. G.). **The Date-stone Beetle in California and Lower California.**—*J. econ. Ent.* **36** no. 5 pp. 804–805, 1 fig., 11 refs. Menasha, Wis., 1943.

Coccotrypes dactyliperda, F., was found in waste dates collected from the ground in California in 1932 and 1934, and 100 per cent. infestation was found in a sample of dates harvested in Lower California in October 1942 and imported into California in May 1943. The dates showed 1–23 perforations and the stones contained all stages of the beetles, the majority being adults. The distribution of this Scolytid and the seeds from which it has been recorded in the literature are briefly reviewed ; it has been found in seeds of several palms, including dates, in Hawaii [*R.A.E.*, A **16** 634], but is not considered a pest there, as it attacks them only when they are on the ground. In Lower California, the beetles probably attack the mature dates while they are being sun-dried ; they perforate the surface and form communal galleries in the stone. If, as seems likely, the green fruit is not attacked on the tree, reducing the drying period to a minimum, protecting the fruit during drying and fumigating it adequately before packing should prevent serious injury. In southern California, infestation is unlikely as dates are rarely sun-dried, but are picked when nearly ripe and quickly transferred to packing houses.

MCGREGOR (E. A.). **Toxicity of Anabasine to the Citrus Thrips.**—*J. econ. Ent.* **36** no. 5 p. 805. Menasha, Wis., 1943.

The author records that he has tested free anabasine (1 : 1,000 and 1 : 2,000) and anabasine sulphate (1 : 600 and 1 : 800), with and without sugar, against the citrus thrips [*Scirtothrips citri*, Moult.] in the laboratory in California by placing adult thrips in cages containing lemon leaves bearing dried deposits of the solutions. Sugar-containing residues, with the exception of the 1 : 2,000 dilution, gave mortalities of 99·1–100 per cent. in 1–4 days when freshly deposited or not more than three days old ; deposits of free anabasine (1 : 2,000) and sugar killed 78 per cent. of the thrips in four days. Residues of free anabasine (1 : 1,000) without sugar gave mortalities of 60–100 per cent. in 2–4 days.

LANGE jr. (W. H.). **Dichlorethyl Ether for Cabbage Maggot Control.**—*J. econ. Ent.* **36** no. 5 pp. 806–807. Menasha, Wis., 1943.

As a result of increases in the acreage of cabbage in the Salinas Valley of California, a severe infestation of *Hylemyia brassicae*, Bch., occurred during May and June 1943. Injury was confined chiefly to cabbages in seed beds, and was in progress before any control measures were initiated. The usual mercury

compounds were not very effective, but an emulsion of β–β-dichlorethyl ether, applied to the bases of the plants, killed the larvae and acted as a repellent for a limited time. It contained 20 cc. dichlorethyl ether per U.S. gal., emulsified with 4 cc. Tergitol 7 (a sodium sulphate of a higher synthetic secondary alcohol). Applications of 5, 10, 20 and 40 cc. caused no visible injury to cabbage seedlings 4–8 ins. high. In light sandy soils, 8·5 oz. emulsion per foot of cabbage row in the seed bed gave 80–99 per cent. control, but more was needed in heavier soils.

Commercial preparations, usually containing 96 per cent. dichlorethyl ether with an emulsifier, gave satisfactory control when used at the same dosages.

FLANDERS (S. E.). **The Potato Tuber Worm, a Host suitable for Mass Production of *Macrocentrus ancylivorus*.**—*J. econ. Ent.* **36** no. 5 p. 807, 1 ref. Menasha, Wis., 1943.

On the discovery of *Cydia* (*Grapholitha*) *molesta*, Busck, in southern California in the autumn of 1942 [*R.A.E.*, A **32** 114], preparations were begun for the mass propagation of the parasite, *Macrocentrus ancylivorus*, Rohw. In tests to find a laboratory host that could be produced throughout the season, the parasite was found to reproduce on larvae of *Gnorimoschema operculella*, Zell., in potato shoots; in this area *G. operculella* has long been an insectary pest of potato shoots used as a food for various Coccids. Subsequently it was found that the Braconid would oviposit equally readily in larvae in potato tubers, and its mass production was in progress in August 1943. It is known to be present in some parts of California as a parasite of *Cydia* (*Melissopus*) *latiferreana*, Wlsm. [**31** 332].

PEIRSON (H. B.). **Field Book of destructive Forest Insects.**—5th edn., 6 × 3½ ins., [2]+26 pp., ill. [Augusta] Maine Forest Service [1943].

Brief accounts, illustrated by figures, are given of the appearance and biology of 26 insect pests of forests in Maine, together with notes on the damage caused by them and their control. General control measures for different types of insects in forests and on shade trees are summarised, and tables of dilutions for four insecticides are also included.

DONER (M. H.) & THOMSSEN (E. G.). **Clothes Moths and their practical Control.**—*Soap* **19** no. 10 pp. 102–105, 123, 1 fig., 18 refs. New York, N.Y., 1943.

Keys are given to the larvae and adults of *Tinea pellionella*, L., *Tineola biselliella*, Humm., and *Trichophaga tapetzella*, L., which, with carpet beetles, are responsible for nearly 99 per cent. of the insect damage to fabrics used for clothing and house furnishings, with a short general account of their bionomics and a more detailed description of suitable methods of control.

Preventive measures include storage in receptacles that are as airtight as possible and contain paradichlorbenzene or naphthalene, which should be renewed every six months; frequent brushing, sunning and cleaning; removing accumulated lint in crevices; routine applications of suitable fly sprays in cupboards and rooms and on upholstered furniture, and treatment of materials with moth-proofing preparations [*cf. R.A.E.*, A **27** 140, etc.]. Methods of controlling infestations include thorough spraying, fumigating with volatile solids, such as paradichlorbenzene or naphthalene [*cf.* **27** 635], or

liquids, such as carbon bisulphide, or a mixture of ethylene dichloride and carbon tetrachloride ; exposure for several hours to temperatures of at least 135°F., which is lethal to the insects, or storage at 40–42°F., at which temperatures they do not feed, and the use of baits on flypapers, put on the floors to trap the larvae or hung from the ceiling for the adults [*cf.* **29** 255].

Richardson (H. H.), Bulger (J. W.), Busbey (R. L.), Nelson (R. H.) & Weigel (C. A.). **Studies on Nicotine Fumigation in Greenhouses.**—*Circ. U.S. Dep. Agric.* no. 684, 15 pp., 6 figs., 19 refs. Washington, D.C., 1943.

The following is almost entirely based on the authors' introduction and summary. Chemical and insecticidal tests were made with five methods used in the United States for vaporising nicotine as a fumigant in greenhouses. Three of them, the atomiser, pressure-can and exhaust methods, have recently been introduced and consist, respectively, in passing an atomised solution of nicotine in acetone or water through a very hot pipe [*cf. R.A.E.*, A **23** 179], igniting nicotine-impregnated material inside a can from which the vapour is ejected under pressure [**26** 20], and injecting a concentrated solution of nicotine into the exhaust pipe of a petrol engine. By each of these methods, the nicotine was vaporised in the centre of the greenhouse. The other methods comprised igniting small piles of a commercial tobacco powder smudge or commercial nicotine papers distributed down the middle of the greenhouse, combustion taking place in about 4 and 10 minutes, respectively. With all the methods, nicotine concentrations were highest soon after the beginning of fumigation, but fell off rapidly, so that little nicotine remained after the first hour. The atomiser method gave a peak concentration, after 8–10 minutes, of nearly 40 per cent. at dosages of 0·025–0·1 oz. per 1,000 cu. ft., but at a dosage of 0·012 oz., the concentrations were disproportionately lower and the distribution of nicotine varied. Insecticidal action against Aphids was good at the higher dosages, but was generally lower and varied in distribution at the lowest. The atomisation of solutions of nicotine in water appeared to be less effective than that of solutions in acetone. Peak concentrations of about 60, 40 and 30 per cent. of the dosage were given by the pressure-can, exhaust smudge and nicotine-paper methods, respectively, all after 10–15 minutes. The pressure-can appeared very effective and gave good distribution in insecticidal tests, and the exhaust method was also effective, but gave uneven distribution, which could probably be rectified by the use of a blower. The smudge method gave good distribution, but seemed less effective than the atomiser. Nicotine papers gave good distribution and appeared more effective than was indicated by the low concentrations obtained in the chemical tests.

Damp or wet soil and high relative humidity appeared to decrease efficiency at the lower dosages, but had little effect at the higher ones. Nicotine concentrations were generally lower or decreased more rapidly under damp or wet conditions than when the plants and soil were dry. Wetting the infested foliage probably lowers efficiency. There was no indication of a carry-over of nicotine in a greenhouse subjected to repeated fumigations at dosages of 0·05–0·1 oz. per 1,000 cu. ft.

Approximately 80 and 95 per cent. of the insecticidal action in fumigation by the various methods took place in the first 30 and 60 minutes, respectively, and this was corroborated by chemical analyses. The very low concentration of nicotine present at the end of the first hour of fumigation with dosages of 0·025 oz. or more per 1,000 cu. ft. had considerable toxic effect against Aphids exposed from then until the end of overnight exposures (16–17 hours). The insects used in the tests were, in order of increasing resistance, *Aphis rumicis*, L., on nasturtium and *A. gossypii*, Glov., on cucumber (least resistant), *Macrosiphum solanifolii*, Ashm., on lettuce, *Myzus persicae*, Sulz., on radish, *M. porosus*, Sand., on rose and *M. persicae* on turnip, *Thrips tabaci*, Lind., on

onion, *Trialeurodes vaporariorum*, Westw., on tomato, and *Phenacoccus gossypii*, Tns. & Ckll., on *Chrysanthemum*, and *Tetranychus bimaculatus*, Harvey, on rose. Repeated fumigations with nicotine produced no apparent injury to crops of lettuce and tomato and various other vegetable and ornamental plants.

HORTON (J. R.), JONES (E. T.) & WADLEY (F. M.). **The Hessian Fly and its Control by late Sowing of Wheat in Oklahoma and Arkansas.**—*Circ. U.S. Dep. Agric.* no. 687, 10 pp. Washington, D.C., 1943.

Kansas, Oklahoma and Arkansas are near the southern and western limits of the range of *Mayetiola destructor*, Say, and regular and serious injury to wheat there is infrequent except in eastern Kansas. It sometimes occurs in northern Arkansas and north-eastern and north-central Oklahoma, however, and since wheat is an important crop in parts of this area, investigations were made to provide information on the status of the fly and its control in the two States. Its bionomics and the injury caused to wheat are briefly described. The mature larvae in their puparia are the only stage found in winter or, usually, in summer ; active breeding occurs in spring and early summer and is resumed by adults that begin to emerge in September. Some emergence and breeding may, however, take place during the summer, under unusually cool, moist conditions. Drought retards emergence, and some of the larvae in puparia are killed by the long, hot summers of areas in the southern range of the fly, though puparia have been known to remain viable for several years under unfavourable conditions. Warm, dry winds during the hatching period are also detrimental.

Methods of control comprise the use of resistant varieties of wheat, clean farming and delayed sowing to avoid autumn infestation, which is the most important. In general, it is fairly successful, though in years when the flies continue to be active late into the autumn and sowing is consequently very late, the seedlings are not sufficiently advanced to withstand winter weather. Winter injury is not common in the area under consideration, where the winters are less severe than elsewhere in the infested region ; in Oklahoma, pasturing of winter wheat is often practised, and for this purpose, early autumn sowing is desirable. Experiments to determine a compromise range of sowing dates to reduce the total risk as much as possible were carried out intermittently at a number of places in Oklahoma and Arkansas between 1916 and 1935, and the results are shown in tables. Infestation was infrequent in central and south-eastern Oklahoma and at low altitudes in eastern Arkansas, but was more regular and sometimes heavy in north-central and north-eastern Oklahoma and north-central and north-western Arkansas. It appeared to have little effect on yield, however, even at places in northern Oklahoma where conditions most closely resemble those in the eastern soft-wheat areas and infestation was most consistent. The recommended safe dates for sowing vary from 6th October in north-western Oklahoma to 16th October in eastern Oklahoma and the north of Arkansas, except the north-east, from which no conclusive evidence was obtained. Control by delayed sowing may be disappointing in northern Arkansas when mild, moist conditions enable activity to continue very late in the autumn. Dates on which sowings can safely be made were not found to be consistently later in the south than farther north. There was little evidence of any consistent reduction in yield when sowing was delayed until the recommended dates, though at some places a decrease appeared to be associated with very late sowing ; very early sowing is likely to result in the young plants being damaged by heat. It is suggested that the sowing dates should be observed in the more regularly infested localities except in years in which infestation is known to be light, and in the less frequently infested regions only when surveys show that infestation is heavy.

Mills (H. B.). **Montana Insect Pests, 1941 and 1942. Twenty-ninth Report of the State Entomologist.**—*Bull. Mont. agric. Exp. Sta.* no. 408, 36 pp., 8 figs., 2 refs. Bozeman, Mont., 1942. [Recd. 1944.]

This report includes sections by O. B. Hitchcock on the control of grasshoppers and the mormon cricket [*Anabrus simplex*, Hald.] in Montana in 1941–42. In 1941 grasshoppers, of which *Melanoplus mexicanus*, Sauss., was again the commonest, were a major pest of crops in some counties, in spite of a marked decline in population since 1939 [*cf. R.A.E.*, A **29** 536]. No migrations of economic importance occurred in 1941 and only local flights in 1942. Hatching was delayed and reduced by cool damp weather in May and June 1941, and, owing to the abundance of green vegetation along field edges and on abandoned land during most of the summer, little damage was done to winter wheat. Oviposition was reduced by cool wet weather in August–October, and hatching in the spring of 1942 was again delayed, so that most of the crops were harvested before hoppers became noticeable. *M. bivittatus*, Say, was second in importance to *M. mexicanus* in both years, except in the north in 1941, when *M. packardi*, Scud., was second. *M. differentialis*, Thos., *M. femur-rubrum*, Deg., and *Dissosteira carolina*, L., appeared locally in large numbers in 1941, but were negligible in 1942. Heavy mortality of *M. bivittatus* and *M. differentialis*, apparently from a fungous or bacterial disease, was recorded in the eastern area in 1941. About 30 per cent. of the adults of *M. bivittatus* were killed by fungous disease in one county in 1942, and diseases were also prevalent in other districts. Large numbers of egg pods were destroyed by Meloid larvae in 1941 and by Bombyliid and Meloid larvae in 1942. Poison-bait was distributed in both years, though over a smaller area in 1942. The total crop losses attributable to grasshoppers and the value of the crops saved by control measures were estimated at $1,420,292 and $4,231,409 in 1941 and $1,599,695 and $817,671 in 1942, respectively.

Infestation by *Anabrus simplex* also declined during both years [*cf.* **29** 537], and no extensive migrations were observed. Control measures were necessary in five counties in 1941 and two in 1942. The use of a bait containing sodium fluosilicate [*cf.* **30** 62] has now almost completely superseded dusting with sodium arsenite for the control of this Tettigoniid. An investigation in Beaverhead County in the autumn of 1941 showed that large numbers of adults had survived the control campaign of that summer, but few were present in the early summer of 1942. Many eggs were found in the ground, however, and it was apparent that this is one of the areas in which they require two years to hatch [*cf.* **30** 171]. Of the eggs collected in autumn, 60 per cent. contained well-developed embryos, making serious infestation likely in 1943, 10 per cent. were not viable and 30 per cent. were parasitised by the Scelionid, *Sparasion pilosum*, Ashm. Parasites that emerged from eggs attacked in the autumn of 1941 were able to parasitise eggs that had escaped attack at that time. The predacious Sphegid, *Palmodes laeviventris*, Cress., was present in most infested areas, but afforded little control.

The Pentatomid, *Chlorochroa sayi*, Stål, was uncommon in both years, but caused some injury to potato in 1941 [*cf.* **31** 497]. Incipient outbreaks of *Paratrioza cockerelli*, Šulc, on potato were checked in 1941 and 1942 by high temperatures in July and reductions in yields were slight. *Plutella maculipennis*, Curt., is widespread in Montana but is seldom injurious to cultivated crucifers. In the summer of 1941, however, it did considerable damage by destroying the seeds of mustard. It was also abundant on several wild mustards, notably tumbling mustard, *Norta* (*Sisymbrium*) *altissima*. *Loxostege sticticalis*, L., was numerous locally on sugar-beet in 1941 and also on flax, which was defoliated. In one flax field, 50–70 pupae were present per square foot of soil. Summer-generation adults appeared in large numbers, but 90 per cent. of them were sterile [*cf.* **30** 461]. Fairly large numbers of adults were observed in June

1942, but few eggs were laid. Some summer-generation adults appeared in the north, but all were sterile. The worst outbreak of *Chorizagrotis auxiliaris*, Grote, for several years occurred in the spring of 1942 over a large area in the east of Montana, and there was considerable local damage to crops. Infestation of sweet maize by *Heliothis armigera*, Hb., throughout the State in the spring of 1941 was the heaviest for many years, and many early plantings were a complete loss. The winter had been mild, and the adults began to oviposit before the appearance of the silks; such early activity suggests the possibility of overwintering in this region. Infestation was light in 1942.

Sitona cylindricollis, Fhs., a serious pest of sweet clover [*Melilotus*] that has spread rapidly westward since it was first recorded in the United States in 1933 [**22** 256], was taken in eastern Montana in September 1942. Infestation of peas by *Bruchus* (*Laria*) *pisorum*, L., has increased in some parts of Montana in recent years. Surveys of the two most heavily infested areas towards the end of June 1942 showed that the Bruchid was widespread but not generally abundant. The increase was probably due to the use of infested seed peas in the spring of 1942 and to a series of mild winters with considerable snowfall, which would enable greater numbers to overwinter out-of-doors. Overwintering, but not breeding, occurs in stored peas.

A wet, cool spring and retarded crops in 1942 favoured infestation by *Hylemyia cilicrura*, Rond., which was abundant in the Yellowstone Valley and caused 10–30 per cent. loss of bean seedlings on light, sandy soils by mid-June, and also damaged seedling maize and peas. Damage is usually restricted to soils rather rich in humus and can be reduced by thorough mixing of the humus and cultural processes that dry the soil surface. Larvae of *Hylemyia brassicae*, Bch., caused injury to early turnips in the spring of 1942, but attacks on cabbages nearby were not severe. The larvae mine in the plant below the soil, and damage is worst in cool, moist seasons. Young plants can be protected by sprinkling the soil round the roots with a mixture of $\frac{3}{4}$ oz. mercurous chloride (calomel) and 1 oz. gum arabic to 10 U.S. gals. water. *Cephus cinctus*, Nort., has caused extensive damage to wheat in the eastern plains of Montana during the past few years.

Brief notes are given on the bionomics of the weevils, *Anthonomus scutellaris*, Lec., the most important pest of plum fruits in Montana, and *Conotrachelus nenuphar*, Hbst., which is primarily a pest of stone fruits but also attacks apples, and was taken on plums in 1942. It had not previously been found in Montana, but apples showing scars typical of those caused by it had been observed in 1922. Both these weevils can be controlled by spraying with lead arsenate. Larvae of *Schizura concinna*, S. & A., which are described, were observed feeding on the leaves of apple in August and September. Notes are also given on the bionomics and control of the Aegeriid, *Pennisetia* (*Bembecia*) *marginata*, Harr., and a species of *Byturus*, for which the name *unicolor*, Say, is used [*cf.* **31** 5]; both are sometimes pests of raspberries in Montana. The larvae of *P. marginata* weaken or kill the plants by boring into the canes, and later into the crowns, and overwinter twice; those of *Byturus*, which has one generation a year, feed on the core of the fruit. The Aegeriid can be controlled by destroying infested canes and by spraying with summer oil against the eggs, which are laid on the canes and leaves. *Byturus* can be controlled by a spray of lead arsenate or a dust of 0·5 per cent. rotenone applied against the adults before they oviposit. One application should be made when the buds are forming and another a fortnight later.

Harmologa (*Archips*) *fumiferana*, Clem., caused considerable damage to Douglas fir (*Pseudotsuga taxifolia*), Engelmann spruce (*Picea engelmanni*) and alpine fir (*Abies lasiocarpa*) in the Gallatin Forest in the summer of 1942. Larvae were abundant on 10th July but were not found on 9th August. Parasites reared from them comprised *Glypta fumiferanae*, Vier., and an undescribed species of *Microgaster*.

HARRINGTON (C. D.), SEARLS (E. M.), BRINK (R. A.) & EISENHART (C.). **Measurement of the Resistance of Peas to Aphids.**—*J. agric. Res.* **67** no. 10 pp. 369–387, 3 figs., 8 refs. Washington, D.C., 1943.

The authors describe the development of a procedure for measuring the resistance of pea plants to attack by *Macrosiphum onobrychis*, Boy. (*pisi*, Kalt.) that is primarily designed for greenhouse use, but may be used, with modified equipment, under field conditions. The superiority of resistant over susceptible plants is due principally to the fact that the Aphids on them increase more slowly and so require a longer infestation period to reach damaging numbers. As the principal factor concerned is the inhibition of reproduction on resistant plants, the reproduction rate was used as the criterion of resistance. If plants of varying resistance are individually infested with a single newly reproducing Aphid from a uniform stock, progeny counts after 6–8 days will reveal their comparative resistance. Counts after a given period, however, are not comparable if trials with different plants are made at different temperatures, and accumulated degree hours were therefore adopted as a basis, Fahrenheit temperatures being used. Each trial was terminated when 4,750 effective degree-hours had accumulated; this number permits the parent Aphid to produce the greatest possible number of progeny, but stops the trial before the young begin to reproduce. Temperatures above 43°F., the threshold of development, were considered effective in promoting Aphid reproduction. It was found that within the optimum testing range of 55–75°, changes in the speed of reproduction were closely proportional to changes in the rate of accumulation of effective degree-hours; when fluctuations beyond this range occurred, the average temperature calculated at the end of the experiment was found to be useful in indicating the extent to which the rate of reproduction had deviated from the rate of accumulation of effective degree-hours. Fairly consistent results were given provided that the average temperature lay between 60 and 75°; average temperatures below 60° tended to inhibit reproduction on all plants to such an extent that small differences in the resistance were masked, and average temperatures above 75° resulted in undue magnification of differences because of increased mortality of parent Aphids on the more resistant plants. At the end of the trial, the Aphids were removed from the plants and counted, and the condition of the parent noted; normal parent Aphids were usually found associated with susceptible food-plants and emaciated ones with resistant plants. Small numbers of progeny resulting from diseased or parasitised parents should be differentiated from those due to plant resistance.

The results of a number of tests carried out by this technique are analysed statistically, and three methods of combining the results of separate trials are shown. No variety of pea was found to exhibit a high degree of resistance to the Aphid, and it is therefore considered unlikely that new varieties of greatly superior resistance will be developed in the near future, though the incorporation of partial resistance, such as was found in one variety, into other peas having more desirable canning qualities would be of value.

HILLS (O. A.). **Comparative Ability of several Species of *Lygus* and the Say Stinkbug to damage Sugar Beets grown for Seed.**—*J. agric. Res.* **67** no. 10 pp. 389–394, 3 figs., 1 ref. Washington, D.C., 1943.

An account is given of experiments carried out in Arizona in 1940 to determine the potential and comparative ability of nymphs and adults of both sexes of *Lygus hesperus*, Knight, *L. oblineatus*, Say, and *L. elisus*, Van D., to reduce the viability of seed balls of sugar-beet and to compare this damage with that caused by adults of *Chlorochroa sayi*, Stål [*cf. R.A.E.*, A **30** 430].

In December 1939, groups of plants in the field were sprayed with pyrethrum extract in oil and protected from infestation by means of screen cages, and in

the following April, at the beginning of the blooming period, sleeves were tied over individual spikelets with sufficient flowers to develop 300–400 seed balls. Some sleeves were left as controls, and adult males, adult females or nymphs of the three species of *Lygus* or adults of *C. sayi* were placed singly in each of the others. The bugs were kept in the sleeves until the seed matured, dead insects and nymphs that transformed being replaced. The seed balls were then stripped from the plant and counted, and germination analyses made to determine their viability.

There were significantly more non-viable seed balls in all sleeves containing insects, except those containing males of *L. elisus*, than in the control sleeves, and more in the sleeves of *C. sayi* than in any of the *Lygus* sleeves. In general, feeding by *Lygus* rendered all the seeds within the ball non-viable, whereas in the case of *C. sayi*, one or more of the seeds in certain viable balls were not viable. None of the insects appeared to cause a reduction in the number of seed balls produced. There were many more viable than non-viable seed balls in the *Lygus* sleeves, indicating that the damage had reached its maximum, but in the *Chlorochroa* sleeves, the number of viable balls was considerably smaller, and it is possible, that if these sleeves had contained more seed balls, the number of non-viable balls might have been greater. Nymphs and females of *Lygus* were equally injurious and caused more damage than the males; *L. elisus* damaged significantly fewer seed balls than either *L. hesperus* or *L. oblineatus*.

PATTON (R. L.). **The Excretion of Arsenic by the Malpighian Tubes of** *Galleria mellonella*, *Tenebrio molitor*, **and** *Rhodophora florida*.—*J. agric. Res.* **67** no. 10 pp. 411–415, 13 refs. Washington, D.C., 1943.

The following is based on the author's summary. The rates of absorption of the arsenious ion by the Malpighian tubes of larvae of *Galleria mellonella*, L., *Tenebrio molitor*, L., and *Rhodophora florida*, Gn., were determined and compared. *G. mellonella*, the species most susceptible to arsenic poisoning, showed a reduction in the rate of absorption of saline solution when sodium arsenite was added to it, but the reduction was of indeterminate significance. The other two species showed no significant difference. None of the enzyme systems estimated was affected. From the measurements made, it is apparent that the Malpighian system of insects plays a definite rôle in the elimination of arsenic from the blood; however, the data gave no indication that the function of these organs is the important factor in the relative susceptibility of insects to arsenic poisoning.

ISELY (D.). **The Grape Rootworm.**—*Bull. Ark. agric. Exp. Sta.* no. 426, 26 pp., 5 figs., 15 refs. Fayetteville, Ark., 1942. [Recd. 1944.]

Fidia viticida, Walsh, caused serious injury to grape-vines in Arkansas in 1928, when it was erroneously identified as *F. longipes*, Melsh. [*R.A.E.*, A **18** 390], but almost disappeared during the dry years of 1930–1936. Following favourable weather in 1937, it was again destructive in and after 1938, and in 1941 it occurred in 87 per cent. of all the vineyards visited, accompanied occasionally by *F. longipes*. The original descriptions of the adults of these two Eumolpids and characters distinguishing them are quoted, all stages of *F. viticida* are described, its distribution in the United States is reviewed, and an account is given of investigations in 1941 and 1942 on its bionomics and control in Arkansas.

The durations of the stages in the life-cycle were studied in an insectary under out-door temperatures, and other observations were made in vineyards. The results indicated that the life-cycle may require one or two years. The eggs are laid in batches of 20–60 under the bark scales of the vines, mostly in the second half of June, and hatch in 5–11 days. The larvae burrow into the soil

and feed on the small roots, which they destroy, and on the inner bark of the larger roots ; they sometimes feed for a few days under the bark of the stems before attacking the roots. The larger larvae usually feed on the roots externally but burrow in the bark if it is very thick. When numerous, they may girdle the main roots. Hibernation occurs in the larval stage at depths varying from a few inches to nearly 2 ft. Of the 440 larvae reared, 45 per cent. completed their larval development before hibernating, and pupated in the following spring with no resumption of feeding, whereas the others resumed feeding, formed pupal cells in early summer, and remained inactive during the remainder of the growing season, apparently requiring to hibernate a second time before pupation. The pupal stage lasts 11–17 days. Soil cultivation has been found of value against the pupae in the Lake Erie region of the United States, where most of them occur within 3 ins. of the surface, but would not be effective in Arkansas, where they are at all depths down to at least 18 ins.

The adults emerge from the soil over a period of about three weeks, and live for about a month. They first appear about mid-May, when blossoming of the vines is over. They feed on the leaves and, in Arkansas, sometimes on the green fruits, and cause severe damage when very abundant but are generally less injurious than the larvae. When disturbed, they usually drop to the ground, but may fly if the temperature is above 70°F. They are particularly active late in the morning, but hide under the leaves during the hot part of the day. They begin to oviposit after feeding for about a fortnight.

Spraying with lead arsenate against the newly emerged adults gave fair results in 1929 but was not adequate against the more severe infestations that developed in 1938 and subsequent years. In the experiments in 1940, barium fluosilicate as a dust and cryolite as a dust or spray injured the leaves so severely that they were not tested further, though they killed many beetles, but derris dusts and sprays were effective, and further tests with them were made in 1941. The derris contained 4 per cent. rotenone and the percentage control was estimated by counts of the beetles alive on the leaves and dead on the ground. Sprays of 2, 3 and 4 lb. per 100 U.S. gals. water showed 75·6, 89·1 and 87·5 per cent. control after four days ; and a spray of 3 lb. per 100 U.S. gals. and a dust of derris and talc (1 : 4) showed 91 and 99 per cent. after three.

Snapp (O. I.) & Thomson (J. R.). **Life History and Habits of the Peachtree Borer in the southeastern States.**—*Tech. Bull. U.S. Dep. Agric.* no. 854, 24 pp., 12 figs., 4 refs. Washington, D.C., 1943.

The following is largely based on the authors' summary of this account of the methods and results of investigations on the biology of *Aegeria* (*Sanninoidea*) *exitiosa*, Say, on peach in Georgia, carried out in 1930–38 as an aid in timing applications for control. This Aegeriid is indigenous in the United States, occurring chiefly from the Rocky Mountains eastward and from New England to the Gulf of Mexico. It is primarily a pest of peach, though related trees are subject to attack. The larvae feed on the cambium and inner bark of the trunk, usually just below but sometimes just above soil level, and occasionally attack the larger roots. They pupate in cocoons just below the surface of the soil close to the tree or, if they have been feeding above ground, in exit holes cut through the bark.

There is normally one generation in the year in Georgia, though two were shown to be possible under certain conditions, and the winter is passed in the larval stage. Pupation began as early as 19th April under orchard conditions, but almost all the larvae entered the prepupal stage in July–September, 55–80 per cent. doing so in August. Moth emergence began as early as 9th May and extended to 8th November, the peak usually occurring about the middle of September. Males were more numerous early in the emergence period and females during the peak and end of it ; 53·1 per cent. of 1,325 moths that

emerged in three seasons were females. These did not fly far and showed a marked tendency to deposit many of their eggs on the tree from which they had emerged, but males dispersed more quickly and over a larger area. Oviposition usually began on the day of emergence, and was not confined entirely to peach trees ; some eggs were laid on grass, stumps, sticks, and leaves of various plants and on the soil. Females kept under orchard conditions deposited nearly all their eggs within three days after mating, and laid an average total of 515. The average durations of adult life were 5–11·2 and 7–10·3 days for males and females in the insectary and 3·8–8·4 days for females in the orchard. Oviposition occurred from 19th May until 8th November, and hatching from 30th May until 15th December. The egg stage required 8–44 days, and the larval stage 264–383 days, a retardation or cessation of growth occurring under natural conditions between the end of October and the middle of March. The prepupal and pupal periods of females averaged 4·4 and 19 days, respectively, in one year.

The eggs were parasitised by *Telenomus quaintancei*, Gir., the larvae by *Bracon* (*Microbracon*) *sanninoideae*, Gah., and the pupae by *Villa* (*Anthrax*) *lateralis*, Say, which has been known to attack as many as 4·48 per cent. The most important predators were field mice and rats, which dig out large numbers of cocoons from the soil ; others are the ants, *Dorymyrmex pyramicus*, Roger, *Solenopsis geminata xyloni*, McCook, and an undetermined species of *Pheidole*, Chrysopid larvae, spiders, pigs, moles and skunks.

McGregor (E. A.). **Anabasine and Geserol vs. Citrus Thrips.**—*Calif. Citrogr.* **29** no. 2 p. 30. Los Angeles, Calif., 1943.

Experiments having shown that anabasine and anabasine sulphate were effective against the citrus thrips [*Scirtothrips citri*, Moult.] in the laboratory [*cf. R.A.E.*, A **32** 210], further tests were carried out on lemon trees in California in 1943. In a grove in an area in which the thrips is resistant to tartar emetic, 50 U.S. gals. anabasine sulphate (1 : 600) with blood albumin spreader, applied to about 60 small trees on 16th August, reduced the population from 14·3 to 0·8 per unit area in three days and kept it at a level of approximately 7 or less per unit area until 28th September, when the last count was made. A spray of 1 U.S. quart nicotine sulphate and 8 lb. sugar per 100 U.S. gals. reduced the population to 0·6 per unit area and kept it at 6–8 or less per unit area for four weeks, but after six weeks the population on these trees was the same as on untreated ones (20–21 per unit area). Both treatments were followed by a cycle of new foliage development, and this occurred somewhat earlier and a little more profusely in the plot sprayed with anabasine ; very little new growth developed in the untreated plot. Neither treatment caused visible injury to fruit or foliage. In a grove containing non-resistant thrips, a spray of anabasine sulphate (1 : 600) with sugar or blood albumin, applied to heavily infested 3½-year-old lemon trees at the rate of about 1 U.S. gal. per tree, reduced the population from 23·4 to 0·1 and 0·2 per unit area, respectively, in three days, and a spray of 3 lb. each of tartar emetic and sugar per 100 U.S. gals. from 24·7 to 1·4 per unit area. The populations remained low for 35 days after treatment, and that on unsprayed trees continued to be high for eight days and then fell to approximately 12 per unit area. New foliage that developed soon after spraying was rather earlier and more profuse on the plots that received anabasine. No spray injury was detected in these plots and negligible injury in those sprayed with tarter emetic.

In laboratory tests, adults of *S. citri*, placed on lemon leaves bearing freshly dried residues from sprays containing 0·2–2 per cent. 2,2-bis (parachlorphenyl)–1,1,1-trichlorethane [*cf.* B **32** 39], which is known as geserol or DDT, and was emulsified with trichlorethylene, oleic acid, potassium hydroxide and water,

were all dead in less than 24 hours. When they were placed on leaves with residues one day old, mortality was complete in less than 24 hours for concentrations of 0·5 or 2 per cent. geserol and in 41 hours for 0·2 per cent. A dust prepared by grinding together 20 per cent. geserol in talc gave complete mortality of adults in four hours when they were put on freshly dusted lemon leaves bearing 98 mmg. geserol per sq. cm. One containing 2 per cent. geserol in talc caused 91–98 per cent. mortality in 24 hours and complete mortality in 41–48 hours of adults put on freshly dusted leaves bearing 1·4, 3·4 and 9·8 mmg. geserol per sq. cm.; it gave complete mortality in 48 hours with deposits of 1·4 and 3·4 mmg. two days after dusting, and with the heavier deposit six days after. In one test with the larvae, the 2 per cent. dust killed all in 24 hours when applied at the rate of 1·4 mmg. geserol per sq. cm. Geserol dusts caused no injury to tender lemon leaves, but the 0·2 per cent. emulsion caused injury to very tender leaves in one instance.

EBELING (W.) & LADUE (J. P.). **Field Experiments with Oil-toxicant Sprays for Red Scale.**—*Calif. Citrogr.* **29** no. 2 pp. 32, 40, 52–53, 2 figs., 11 refs. Los Angeles, Calif., 1943.

A survey of *Citrus* trees in California that had been sprayed with oil emulsion containing oil alone or with the addition of derris extractives revealed no increase in the control of the California red scale [*Aonidiella aurantii*, Mask.] after 6–8 months due to the use of the extractives, probably because the oils contained very low concentrations of rotenone (usually 0·05 per cent. or less), which were insufficient to overcome the disadvantage resulting from the reduced deposit of oil on the tree surface caused by the emulsifying properties of the mutual solvents [*cf. R.A.E.*, A **28** 617]. Investigations were therefore carried out to determine what concentration of extractives will cause a substantial improvement in the effectiveness of spray oil against the scale, as regards both immediate kill and residual effect. The sprays were applied to heavily infested lemon trees and their efficiency was measured by the percentage survival of adult female scales on the grey bark.

The toxic constituents of cubé or derris root may be added to spray oil by extracting the toxic material from the ground root with a suitable solvent and incorporating the rotenone into the oil by means of a mutual solvent or by extracting the toxic constituents directly from the finely ground root (200 mesh) with the spray oil itself. Some mutual solvents, such as Cardolite 627 [*cf.* **31** 491], form predominantly colloidal solutions of extractives, which are less effective per unit of extractives in the oil than the molecular solutions resulting when certain esters, ketones, ethers and other simple organic solvents are used. The latter, however, have the disadvantage of being more expensive, as large quantities are necessary, and of reducing the deposit of oil by their emulsifying properties. When ground derris or cubé root was mixed in oil immediately before this was poured into the spray tank, adequate concentrations of extractives were not obtained, but it was found that soaking ½ lb. cubé root (5 per cent. rotenone) in 1 U.S. gal. light-medium emulsive oil for 20 minutes resulted in a concentration of 0·4 per cent. rotenone plus deguelin (approximately 40 per cent. rotenone) in the oil.

When sprays of 1·75 per cent. medium oil, alone and with different concentrations of rotenone, were applied in August 1942, one of derris extractives, *n*-butyl phthalate and emulsive oil in which the oil contained 0·05 per cent. rotenone caused no significant increase in mortality over oil alone (40·4 per cent. survival), probably because the oil deposit per sq. cm. was only $75{\cdot}7 \times 10^{-6}$ ml. as compared with $97{\cdot}8 \times 10^{-6}$ ml. from oil alone; when the rotenone content of the oil was increased to 0·187 per cent., only 7·3 per cent. of the scales survived. A spray of derris extractives, Cardolite and tank-mix oil, the oil again containing 0·05 per cent. rotenone, caused a substantial decrease in percentage survival; in this case,

the oil deposit was $107{\cdot}9\times10^{-6}$ ml. per sq. cm., indicating that if the mutual solvent does not reduce the oil deposit, even a small concentration of extractives will result in a substantial increase in effectiveness. The addition of greater amounts of extractives did not increase the effectiveness of the spray, apparently because large quantities of Cardolite interfere with the proper emulsification of the oil and only a certain concentration of extractives can be brought into free molecular solution in oil by means of Cardolite, the remainder occurring in colloidal solution, in which state they are less effective. When cubé root containing 5 per cent. rotenone was stirred in the oil for approximately half a minute and allowed to soak for 20 minutes before being poured into the spray tank, the concentration of rotenone in oil was 0·05 per cent. for $\frac{1}{4}$ lb. cubé per U.S. gal. oil and 0·08 per cent. for $\frac{1}{2}$ lb. This mixture showed the greatest insecticidal efficiency per unit of rotenone in oil; the ground root had little effect on oil deposit, which was $89{\cdot}5\times10^{-6}$ ml. per sq. cm. leaf surface.

A spray containing 1·75 per cent. light-medium emulsive oil, applied on 2nd April 1943, resulted in 62·5 per cent. survival on 5th May. The percentages surviving were 35·1 when a 5 per cent. solution of derris extractives (30 per cent. rotenone) in *n*-butyl phthalate was added at the rate of one part in seven parts oil, in spite of a reduction in the oil deposit from 83×10^{-6} to $53{\cdot}2\times10^{-6}$ ml. per sq. cm.; 23·5 when $\frac{1}{2}$ lb. ground cubé root (5 per cent. rotenone) per U.S. gal. was soaked in the oil for 20 minutes; and 19·1 per cent. when the same quantity of cubé root was stirred in the oil continuously for 20 minutes. The lack of significant difference in effectiveness between the last two sprays, in spite of the fact that the combined rotenone plus deguelin contents of the oil were 0·18 and 0·34 per cent., respectively, suggests that extraction of the toxic constituents of the ground root continues during the spraying period.

To determine the relative residual effect of oil sprays with and without added toxicants, trees sprayed on 6th July 1942 with 2 per cent. light-medium oil alone, with 5 per cent. derris extractives in *n*-butyl phthalate used at one part to seven parts of oil, with 10 per cent. derris extractives in diamyl phenol, used at one part to 15 parts of oil, and with cubé root soaked in the oil for 30 minutes at the rate of $\frac{1}{4}$ lb. per U.S. gal. were examined at once and on 7th December. The percentage survival immediately after treatment was approximately 40 for oil alone and less than 10 for oil with the added toxicants, and the percentage of infested fruits five months after treatment was almost 100 for oil alone and about 50 or less for oil with toxicants. Eventually, however, practically all the fruit would become infested if the trees were allowed to remain untreated.

If scales are completely immersed in oil, they appear to live as long in emulsive oil or oil to which derris or cubé extractives have been added as in tank-mix oil, indicating that death is brought about by suffocation rather than by toxic effect if the spiracles are plugged by the oil. Examination of 1,000 scales two hours after treatment showed that 39·9 and 33·5 per cent., respectively, of those treated with oil alone and with $\frac{1}{2}$ lb. cubé root per U.S. gal. oil had plugged spiracles. Since the respective percentage mortalities were 37·5 and 80·9, it appears that few if any of the scales that were not suffocated by the oil succumbed to treatment with oil alone, whereas nearly 75 per cent. of them succumbed to oil with cubé root in 34 days, so that derris and cubé extractives appear to be of value only against those scales that do not receive enough oil to plug their spiracles or enter their tracheal system.

Manganese sprayed Trees susceptible to Fumigation Injury.—*Calif. Citrogr.* **29** no. 2 p. 42, 1 fig. Los Angeles, Calif., 1943.

It has been known for some time that leaf drop and fruit injury is likely to occur on *Citrus* trees fumigated with hydrocyanic acid gas shortly after they

have received a spray containing copper to correct supposed nutritional deficiencies. The same susceptibility to cyanide injury has recently been found to result from sprays containing manganese, though zinc has never caused it. The injury following manganese sprays appears to be accentuated by fumigation with wet tents during nights of high humidity. It is therefore recommended that fumigation should not follow spraying with manganese for at least six months and that it should be carried out with dry tents, preferably during nights of low humidity.

Red Scale Parasite established in S[an] D[iego] County.—*Calif. Citrogr.* **29** no. 2 p. 42. Los Angeles, Calif., 1943.

The Encyrtid, *Habrolepis rouxi*, Comp. [*cf. R.A.E.*, A **31** 328], was liberated against the red scale [*Aonidiella aurantii*, Mask.] on *Citrus* in California in large numbers in 1937 and 1938, but soon disappeared, and it was presumed that it had not become established. In October 1943, however, it was found to be abundant on a few untreated lemon trees infested with the Coccid in lower San Diego County. The fact that it was found only on semi-abandoned, unsprayed trees suggests that it is unable to survive in orchards that are sprayed with oil.

Curtis (L. C.). **The Influence of Guttation Fluid on Pesticides.**—*Phytopathology* **34** no. 2 pp. 196–205, 1 fig., 18 refs. Lancaster, Pa., 1944.

The following is based on the author's summary. Chemical analyses of guttation fluid collected from tomato, cabbage, cucumbers and squash showed that the water contains in solution both organic and inorganic salts of varying concentrations and pH, that the solutes from the same plants may vary from day to day and that the concentration of the solutes may be influenced by soil fertilisation. The guttation fluid from squash plants was shown to bring copper into solution from copper hydroxide, and the guttation fluid from all the plants tested increased the fungicidal action of yellow copper oxide and Bordeaux mixture. The hypothesis advanced to explain how sprays and dusts applied against pests injure the plants is that the guttation fluid increases the solubility of the toxic ingredient, which is then sucked back into the leaf in the guttation drops so that injury occurs from the inside of the leaf. This hypothesis can explain also the process by which on plants previously sprayed with Bordeaux, the copper content of potato leaves can be built up in concentrations toxic to *Empoasca fabae*, Harr. [*cf. R.A.E.*, A **29** 440].

Acree jr. (F.), Jacobson (M.) & Haller (H. L.). *Amorpha fruticosa* **contains no Rotenone.**—*Science* **99** no. 2562 pp. 99–100, 9 refs. Lancaster, Pa., 1944.

Although seeds of *Amorpha fruticosa* were again found to give a positive reaction to the Durham test [*cf. R.A.E.*, A **27** 502] and also to react positively to the Gross-Smith test as modified by Goodhue, both of which have until lately been accepted as specific for rotenone and the rotenoids, especially when applied to leguminous plants, no compounds of this group could be isolated from them. Further investigations showed that they contain a glycoside which, as well as its aglycone, behaves similarly to rotenone in these colour tests.

Smee (C.). **Army Worms or Swarming Caterpillars** (*Laphygma exempta*, **Wlk.**). —*Nyasaland agric. quart. J.* **3** no. 4 pp. 1–15, 4 refs. Blantyre, 1943.

Outbreaks of *Laphygma exempta*, Wlk., on turf, early maize and winter cereals have been only occasional in Nyasaland, but its potential importance has increased with the more extensive cultivation of winter cereals in recent years and it entirely destroyed some crops of wheat in 1942. Its bionomics are briefly

described, and lists are given of outbreaks recorded in South Africa, Southern Rhodesia and Nyasaland between 1878 and 1943 ; in some cases outbreaks in Nyasaland and Southern Rhodesia coincided, but the larvae do not always become abundant over large tracts at the same time. This Noctuid can exist under a fairly wide range of conditions and is probably always present in small numbers throughout Nyasaland ; no evidence of migrations of adults was obtained [*cf. R.A.E.*, A **30** 609], but recent investigations by J. C. Faure in South Africa have indicated the possibility that both *L. exempta* and *L. exigua*, Hb., may migrate over considerable distances. *Cynodon dactylon* was found to be a preferred food-plant of the young larvae of *L. exempta* in South Africa [*cf.* **30** 610] ; this grass is largely used for lawns in Nyasaland.

As outbreaks in South Africa appear to depend on temperature and rainfall [**30** 609], the mean monthly rainfall and temperature records from stations throughout Nyasaland were compared with the ten-year averages from each. Strong indications were obtained that in years in which outbreaks occurred, the rainfall distribution was abnormal or the mean minimum temperatures were higher than usual, or that both factors occurred together. Mean minimum temperatures reflect the night temperatures, on which moth activity and oviposition depend. In normal years, temperature conditions from September to early November would permit the development of outbreaks, but succulent grass on which the larvae can develop is not then available, and minimum temperatures tend to fall from January or February. It is possible that normal rainfall in November and December enables the grass to grow quickly enough to render it unsuitable for young larvae hatching from eggs deposited by the few moths present, and that there is no further growth if normal rainfall continues, reaching a maximum in January and then decreasing.

Outbreaks occur at any time between early December and early April. After low rainfall in November–December, followed by normal or heavy rains and high temperatures, they can be expected to develop in December–February ; one that was associated with high temperatures and low rainfall in November–January appeared to be confined to turf on a golf-course, which probably consisted of species of grass especially suitable for the larvae. Where rainfall is low in December–January, and rainfall and minimum temperatures are higher in February or March, outbreaks may occur in March and April. Temperature is considered to be the most important factor influencing outbreaks ; in April 1943, when minimum temperatures were high and rainfall had been abundant in January and low at the end of 1942, a small outbreak destroyed a planting of wheat, but at another locality where temperatures fell, no outbreak developed. It is probable that there are incipient second generations in March or April, at least when outbreaks occur in December–February, but owing to falling night temperatures, the possible absence of succulent grasses and the effect of parasites, these do not become injurious. A second slight outbreak was, however, recorded in March–April 1940, when the minimum temperatures in February and March were unusually high ; similar high temperatures in February and March 1942 were followed by the first outbreak of the season.

Outbreaks are difficult to control, since contact poisons, even at very high concentrations, are usually effective only against the very young larvae and the successful application of stomach poisons to winter cereals is almost impossible. A thorough application of pyrethrum dust was, however, found to be effective and rapid in action against almost fully-grown larvae, and cryolite dust is recommended in South Africa [**30** 610]. Treatment with these dusts is not considered practicable for general use under conditions in Nyasaland, though small outbreaks on the outskirts of a crop might be controlled by pyrethrum. Poison baits are successful when carefully prepared and distributed with attention to correct timing, but mechanical methods and hand-collection are of little or no value. Some control is given on young crops by jarring the larvae from the plants and crushing them. Suggested precautionary measures

comprise maintaining a wide strip of bare ground round planted areas adjoining the bush, destroying all grasses in the crop area, and keeping grass in the vicinity of crops under close observation and destroying it when larvae appear on it.

SMEE (C.). **Cluster Bug on Tung** (*Agonoscelis puberula*, **Stål**).—*Nyasaland agric. quart. J.* **3** no. 4 pp. 25–26, 1 ref. Blantyre, 1943.

Reports of *Agonoscelis puberula*, Stål, congregating in numbers on the trunks of tung trees [*Aleurites*] are received each October (before the rains break) from two places in Nyasaland. By analogy with *A. pubescens*, Thnb. (*versicolor*, F.), which is common on cotton, beans, cereals and the seed-heads of weeds in Nyasaland and has been reported as clustering on trees in other parts of Africa [*cf. R.A.E.*, A **17** 657], it is assumed that, while on tung, *A. puberula* is undergoing a prolonged dry-season resting period, during which it does not feed. Its normal food-plants are probably the seed-heads of weeds and cereals, and it has been recorded from flax in Kenya.

Swarms of another bug, tentatively determined as *Plataspis wahlbergi*, Stål, have been observed in a number of successive years swarming on certain trees, chiefly *Derris robusta*, during the dry season, but they include nymphs as well as adults and the insects are feeding and developing.

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IMPERIAL INSTITUTE. **Quarterly Bibliography on Insecticide Materials of Vegetable Origin, Nos. 24–25 (July to December 1943).**—*Bull. imp. Inst.* **41** no. 4 pp. 247–251; **42** no. 1 pp. 39–44. London, 1943–44. [*Cf. R.A.E.*, A **32** 32.]

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